Engineering News

Volume 75, No. 17
Issued Every Thursday
Hill Publishing Company

NEW YORK, APRIL 27, 1916

Price, 15 Cents
Contents, First Page
Advertising Index, Last Page

An example of Modern Concrete Construction

Naumkeag Steam Cotton Co., Salem, Mass. Mill 4 stories and basement, 722x135. Storehouse 6 stories, 500x110x55. Lockwood, Greene & Co., Engineers and Architects. Turner Construction Co., New York, Contractors. **Havemeyer Bars Used Throughout.**

Havemeyer Bars are Backed by REAL Service

Concrete Steel Company
42 Broadway - - New York

DISTRICT SALES OFFICES:

Western Office:
CHICAGO, ILL.
Monadnock Block

BOSTON, MASS.
7 Water Street

PHILADELPHIA, PA.
Pennsylvania Bldg.

YOUNGSTOWN, O.
P. O. Box 24

SYRACUSE, N. Y.
Union Bldg.

BIRMINGHAM, ALA.
Brown-Marx Bldg.

Fabricating shops and warehouses:
YOUNGSTOWN CHICAGO PHILADELPHIA NEW YORK BOSTON

Agencies and Stocks in Principal Cities

Lackawanna Steel Sheet Piling for Sewer Trench Work

Contractors who appreciate safety, watertightness and economy in driving, pulling and reuse of material are invariably enthusiastic about Lackawanna Steel Sheet Piling for trench work, and now-a-days many of them consider this steel sheeting as standard equipment.

The American Contracting Company of St. Louis has used hundreds of thousands of square feet of our 14-inch Arched-Web Section on the Milltown Creek Joint District Sewer, and this is what they write: Read it carefully for if you have any sewer jobs you should be able to profit from their experience:

"We wish to state that Lackawanna was used in preference to wood or any other type of steel sheet piling, because we found it easier to drive, also that it was much easier to pull than any other type of piling. This piling was all driven full length, except some which we used for bulk-head piling, which was driven in 17½-foot lengths.

"Our construction necessitated watertightness. We are pleased to state that this piling held back the water; in fact in one place where we had a small ditch along the work, we were compelled to burn holes in the piling in order to allow water to seep through.

"We are more than pleased to recommend your piling for this class of construction work."

Lackawanna Steel Sheet Piling is now made in all desirable weights and sections for trench work, and if you are figuring on particularly difficult conditions, the free advice of our Sheet Piling Engineers is yours for the asking.

Managing engineers should also send for and read our book "Lackawanna Steel Sheet Piling."

LACKAWANNA STEEL COMPANY

General Sales Office and Works: Lackawanna, N. Y.

NEW YORK BOSTON BUFFALO PHILADELPHIA CLEVELAND CINCINNATI CHICAGO DETROIT ST. LOUIS ATLANTA SAN FRANCISCO

Licensees for the manufacture of Lackawanna Steel Sheet Piling:

For Great Britain and British Colonies in the Eastern Hemisphere, Cargo-Fleet-Iron Co., Ltd., Middlesborough, England. For France, Italy, Spain, French Colonies and Protectorates, Italian Colonies and Spanish Colonies in the Eastern Hemisphere: Cie Des Forges & Aciéries de la Marine et d'Homécourt, Paris, France.

236

Engineering News

VOLUME 75 APRIL 27, 1916 NUMBER 17

Reversible Falls Steel-Arch Bridge of 565-Ft. Span

A bridge of unusual interest, third largest among American steel-arch bridges, has been built by the Provincial Government of New Brunswick, Canada, at St. John, crossing Reversible Falls, St. John River. It is a street crossing to take the place of an old suspension bridge close alongside, built in 1852 by William K. Reynolds to the design of Edward Serrell. The increasing density and volume of traffic made the suspension bridge inadequate. The late C. C. Schneider, Philadelphia, was retained as consulting engineer on the question of a new bridge; with his associate, F. C. Kunz, he designed a steel spandrel-braced arch spanning between the sides of the rock gorge.

The structure is of thoroughly modern highway-bridge character as regards detail. This means heavy solid floor and large live-load capacity. The floor is a 6-in. reinforced-concrete slab on I-beam stringers, with a surfacing of 4-in. creosoted wood block. The sidewalks are 4½-in. slabs surfaced with ½-in. cement mortar. Two trolley tracks occupy the middle of the roadway. The bridge also carries an 18-in. cast-iron water main.

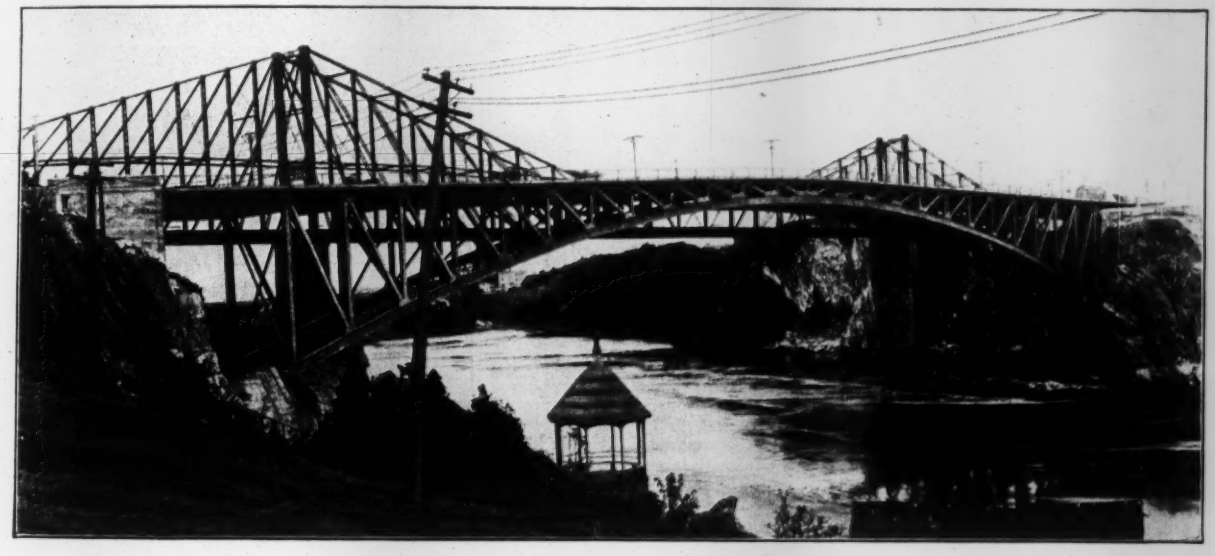


FIG. 1. COMPLETED 565-FT. ST. JOHN ARCH BRIDGE, AFTER REMOVAL OF SUSPENSION BRIDGE

The width and height of the gorge are such as to make the arch of unusually flat proportions. The span is 565 ft. The ratio of rise to span is 1 to 9.2. In due proportion the crown depth is small, 8 ft. 6 in., while the depth at the end post (set 2½ ft. forward of the skewback hinge) is 60 ft. 3 in. The top chord and roadway have an initial grade of 3.215%. The arches are set in vertical planes.

The truss spacing is 41 ft., for a 50-ft. deck, comprising 36-ft. roadway and two 7-ft. sidewalks. The curbs are thus set a short distance in from the inner face of the top chord, and the sidewalk bracket outside the top chord is correspondingly shortened. The panel length is 23 ft. 4 in. uniformly (24 panels).

The dead-loads are summarized by the following tabulation for the completed condition and for erection conditions respectively:

DEAD-LOAD OF ST. JOHN ARCH
(In lb. per lin.ft. of bridge)

After completion:	
Flooring, rails, water pipe, etc.	5,100
Floor system	1,300
Trusses and bracing, average	5,600
Total, average	12,000
Maximum during erection:	
Stringers, floor-beams and rails	700
Trusses and bracing, average	5,600
Total, average	6,300

The average loads given were not used in the calculations, but the actual panel concentrations were taken. A traveler load of 75 tons was taken into account in computing erection stresses.

The live-load was graded for the design of the different structural parts from stringers to main trusses. The specifications for live-load are given in detail in the tabulation shown under Fig. 2 on p. 778.

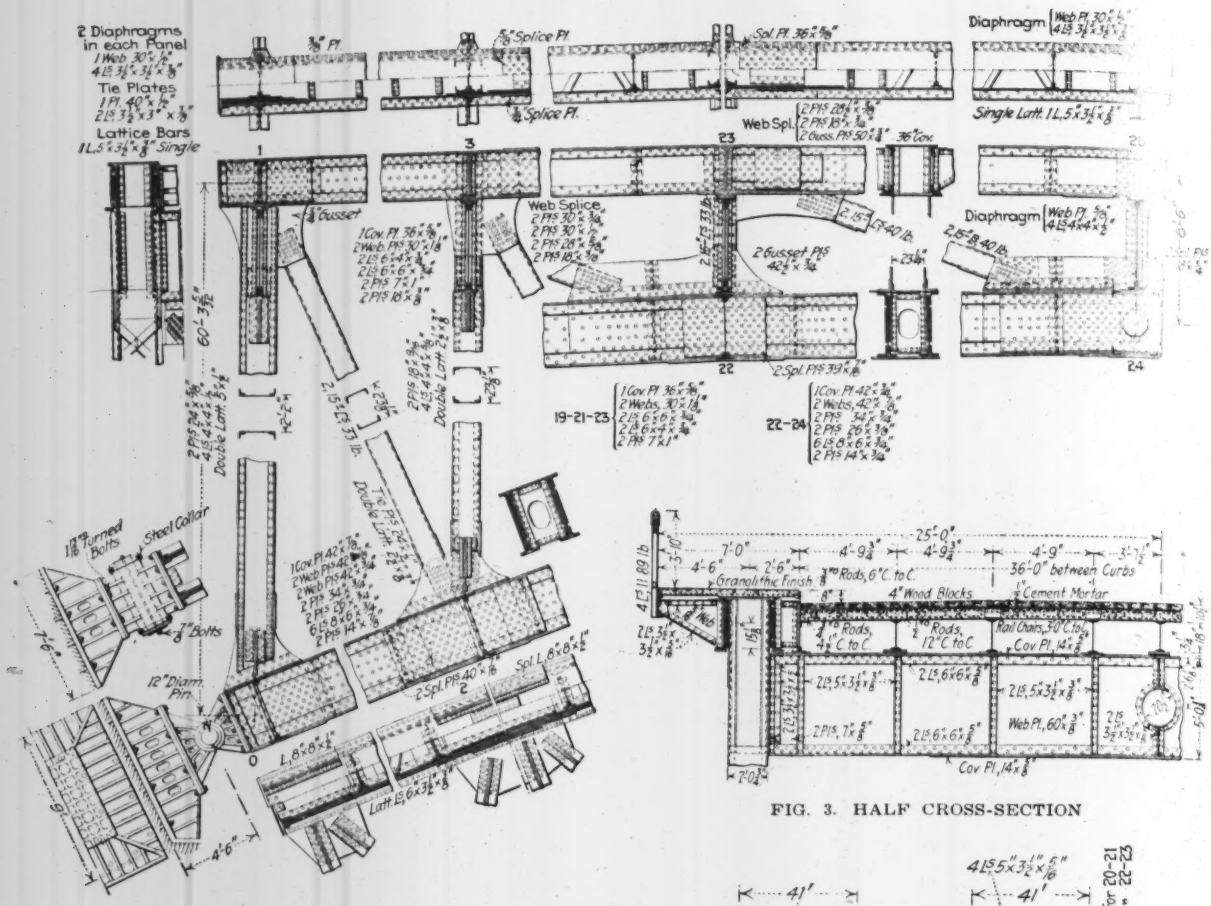


FIG. 2. TYPICAL DETAILS OF ARCH

FIG. 3. HALF CROSS-SECTION

Live-Load Specifications

For roadway stringers, one 20-ton road roller.

For trolley stringers and floor-beams, on each track two 8-wheel 40-ton cars end to end, plus 25% impact.

For sidewalks, 100 lb. per sq.ft.

For main trusses, 3,000 lb. per lin.ft. of bridge. This represents 60 lb. per sq.ft. over the whole area between railings, or else 40-ton 40-ft. trolley cars on each track spaced 40 ft. in the clear on both tracks, and 36 lb. per sq.ft. on all other floor surface.

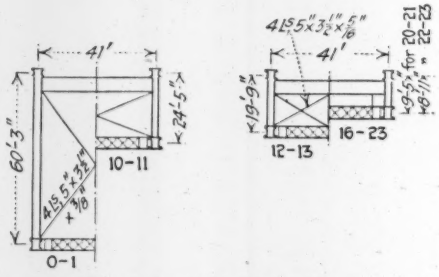


FIG. 5. TYPICAL SECTIONS

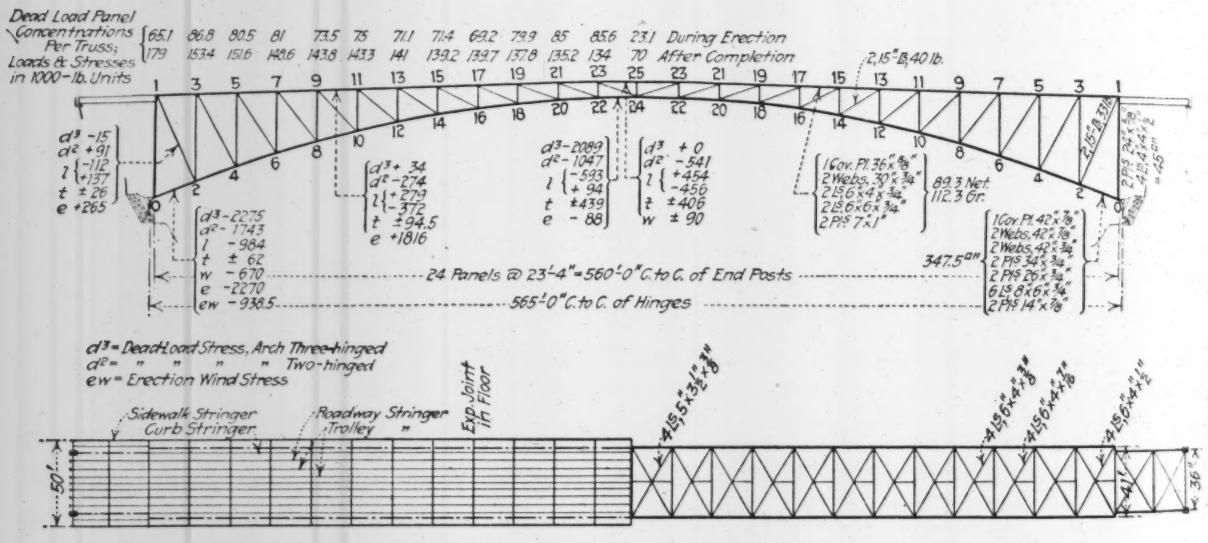


FIG. 4. OUTLINE SKETCH OF REVERSIBLE FALLS ARCH, WITH LOADS AND TYPICAL STRESSES

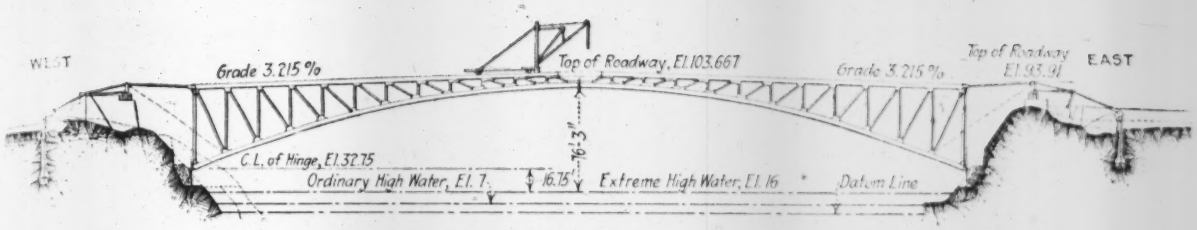


FIG. 6. ERECTION SKETCH OF REVERSIBLE FALLS ARCH

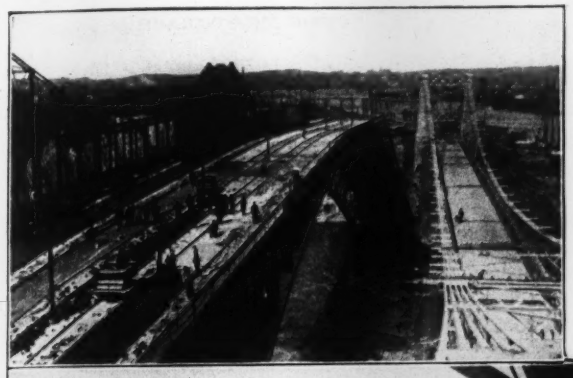
The trusses were erected without falsework, by the usual cantilever method. The arrangement of anchorage and adjusting toggles for the erection and closure is shown by the sketch, Fig. 6.

Closure was made by inserting the top chord member without stress, after lowering the half trusses to contact on a pin at the center bottom-chord joint. The bridge is thus three-hinged for the erection dead-load, but is two-hinged for live-load and temperature.

The main span is flanked by two 46-ft. 8-in. deck plate-girder spans. The total length of steel superstructure is 651 ft. between back walls.

The contract for the work was let early in 1913 by the Chief Commissioner of Public Works, John Morrissy, to the Dominion Bridge Co., Montreal. A. R. Wetmore was Provincial Engineer.

It is of interest to note that the cantilever railway bridge near the arch, which can be seen in the photographs, is, like the suspension bridge, a historic structure. It was erected in 1884, just after Mr. Schneider's Niagara (Michigan Central) cantilever, and thus was among the first three or four of modern cantilevers in America. The Dominion Bridge Co. built it. Its main span is 477 ft. long, containing a 143-ft. suspended span. The suspension bridge, also shown, has since been removed.



FIGS. 7 AND 8. THE THREE BRIDGES AT ST. JOHN, DURING ERECTION OF THE ARCH AND AFTER COMPLETION

Hand Drills in Structural Work

By Charles C. Phelps*

A laborer with chisel or pipe bit and hammer can drill holes of small diameter in concrete at an average rate of about 1 ft. per hr. In brick the rate of cutting is faster. It is apparent that the hand method of cutting is almost prohibitive in cost under many circumstances and would be out of the question if a large number of holes had to be cut in a short time. Various types of rock drills are well adapted to work of this character and, in fact, have been so applied with marked economies in several instances.

A notable job of this nature was the drilling of approximately 9,500 window-bolt holes at the reconstructed Edison Phonograph Works, West Orange, N. J., following the disastrous fire in December, 1914. Each bay required 17 expansion bolts to hold the fireproof steel window frame. It was necessary to drill a hole 3½ in. deep by ¾ in. in diameter in the concrete walls, to accommodate each bolt. These holes necessitated both horizontal and vertical drilling. For the purpose a Jackhamer with a special bit of hexagon steel (Fig. 1) was employed. Two men handled the drill, one holding it and the other guiding the bit (Fig. 2). They averaged 500 holes per day, their work including the frequent moving of scaffold and the changing of air connections. This figure reduces to 15 or 16 ft. of hole drilled per hr. The Jackhamer was used for drilling both horizontal and vertical holes, but many of the up-holes were drilled with a butterfly stope drill (Fig. 3). Both of these drills were also employed for drilling holes preparatory to removing some of the concrete construction.

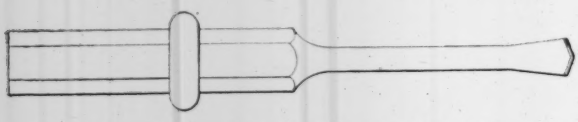


FIG. 1. SPECIAL STEEL USED WITH JACKHAMER FOR DRILLING WINDOW-BOLT HOLES

This is a good illustration of a large number of small anchor-bolt holes drilled economically. An example of a number of large anchor-bolt holes bored at low cost is found in the Quebec Bridge. There were 176 of these holes, 5 ft. deep by 4½ in. in diameter, drilled in granite masonry with a Calyx chilled-shot core-drill. This job was described at length by the writer in *Engineering News* of Feb. 4, 1915.

Miscellaneous Uses for Hand Hammer Drills

Drilling holes in machinery foundations for foundation bolts; in floors for railings; in walls or ceilings for pipe, wire, shafting, conduit brackets or hangers and lighting fixtures; and in walls of buildings for fire-escape brackets are other uses to which pneumatic drills and hammers have been applied with advantage. They are equally valuable for such other applications as cutting openings in floors or walls for windows and doors, shafting, belting, pipes, wires, etc., and for cutting channels in concrete floors or ceilings.

A Jackhamer has seen considerable service along these lines at the Government Printing Office in Washington. The floor construction is of concrete and brick arches, and the ceilings are constructed of concrete tiles. The space between floor and ceiling is used for piping, electric wires, etc., and it is often necessary to cut holes in floor or ceiling when installing machinery or lights, the Jackhamer being employed for the purpose. The drill takes its air from the regular 50-lb. air lines in the Printing Office. When cutting concrete flooring, one man can drill a hole through the floor (10 to 10½ in. thick) in 2½ min. Ladders or staging are required for ceiling work, and for such work two men handle the drill. The automatically rotated type of drill is especially well adapted for use where footing is insecure or elbow room restricted, as on ladders, falsework or swinging scaffolds.

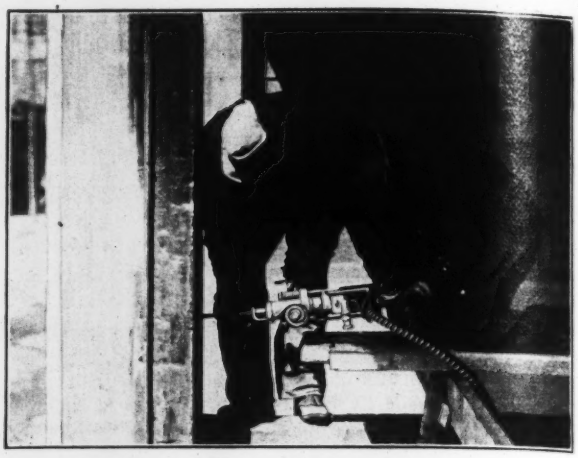


FIG. 2. HAND HAMMER DRILL MAKING WINDOW BOLT HOLES AT THE EDISON PHONOGRAPH WORKS

In another case where hanger holes were drilled in rock it formerly required a whole day for two men with hammer and steel to drill 9 or 10 holes, each 4 to 6 in. in depth, whereas now one man drills the same number of holes in 10 to 15 min. with a hand hammer drill.

Hundreds of elevated-railway column foundations are being removed in New York with the aid of Jackhamers.

FIG. 3. DRILLING UP-HOLES WITH A "BUTTERFLY" STOPE DRILL

*Ingersoll-Rand Co., 11 Broadway, New York City.

These brick footings are located above the new subway in the lower part of the city. They will be replaced by concrete foundations. These footings are in the shape of truncated pyramids 8 or more feet high and about 4 ft. square on top. Fig. 4 shows three of these foundations partly excavated before removal. After the elevated tructure has been supported on falsework, holes are drilled from 12 to 20 in. in depth. The brick is then broken out with sledge-and-wedge.

One of the earlier applications of plug drills for work of this nature was for cutting out concrete and brickwork at the New York end of the Brooklyn Bridge, to make room for a subway terminal. Hammer drills of the non-rotating butterfly type were used, as the more suitable automatically rotated drills had not been developed at that time. The work necessitated cutting through, first, an 18-in. layer of fine cement concrete; next, about 3 ft. of rough gravel concrete; and finally the brick supporting arches or vaulting. The material was cut away in layers or benches—first, the top layer, which, though hard, was fairly uniform and good cutting; next, the rough concrete,

FIG. 4. TYPE OF ELEVATED-RAILWAY COLUMN FOOTINGS REMOVED BY HAND HAMMER DRILLS

which was very difficult to cut; and then the brick, which was comparatively easy cutting. In one instance it was found necessary to cut through a steel tie. This was accomplished with the same drill steel as was used for the concrete, in the surprisingly short time of 12 min. Blasting was prohibited in this confined place—so close to one of the most congested of traffic arteries—and these drills were called upon to pick out all the material piece by piece. For this work a solid hexagon steel with narrow-pointed chisel about ¾ in. across the cutting edge was employed.

A tunnel is being constructed in Seattle to connect the King County courthouse with the City Hall. This work necessitates the removal of large concrete foundations, for which purpose a Jackhamer is employed. This drill was observed to work at as fast a rate as 1 ft. per min.

Large concrete foundations were removed by this method at the Brighton (England) Corporation Electric Works. The concrete was exceptionally hard, and many of the broken blocks weighed as much as 20 tons each. An ordinary chisel bit 20 in. in length was employed for drilling holes all around the foundation, about 9 in. apart and 18 in. deep. The average speed of drilling was 7 holes per hour—that is, about 10 ft. of hole per hour.

When holes are drilled dry in concrete with hand-rotated tools, the natural moisture present in the concrete seems to cause dust from the cuttings to pack and form a mud collar above the bit, making it necessary to withdraw the steel by means of a wrench, which causes considerable delay. This difficulty is not encountered with the automatically rotated type of drill, because its air jet keeps the hole clean and the steel can easily be withdrawn by means of its holder.

Experience with Concrete Roads in Maryland

The State Highway Department of Maryland, under the direction of Henry G. Shirley, Chief Engineer, has built a larger mileage of concrete roads than the highway department of any other state except California and New York. A recently issued report says:

The cost of maintaining macadam, gravel, sand-clay and bituminous roads is such that Chairman Weller and Chief Engineer Shirley soon after their induction into office in 1912 made a careful study and investigation of a more substantial type of construction, especially of concrete. Several experimental sections of concrete roads were laid in 1912. In 1913 six additional miles were constructed, 116 in 1914 and 65 in 1915, making a total to date of about 190 miles.

These roads have been subjected to heavy traffic, and the cost of maintaining them has been almost negligible. When the building of this type of road was started, it was new to most of our contractors and bids on the concrete varied from $1.30 to $1.50 per sq.yd. However, with more experience in this class of work and better equipment facilities, contractors have become more familiar with the handling of concrete and the price has dropped from a maximum of, say, $1.50 in 1912 to a minimum of 90c. in 1915.

The cost of maintaining these concrete roads has been so small that the commission feels that the building of so many miles of them has been of great benefit to the state. With reasonable attention, these roads should last many years. In fact, if a bituminous covering is applied after the concrete surface nas worn a certain amount, they should last indefinitely. Most of the concrete roads built during the last two years have not been covered, as it was found unnecessary to cover them for a period of four or five years under normal traffic and that after this period a bituminous coating adheres very much better than if applied when the road is first completed. This also saves the cost of this surfacing for that period. In many places on the Eastern Shore, concrete has been laid at a lower cost than macadam.

The method of repairing cracks in the concrete is the usual one of applying melted tar and sand. This work is now so well standardized and the repairs made in this way are so satisfactory that cracks in concrete roads are no longer considered of any especial importance. Reinforcement has not been used on the Maryland concrete roads; and even though its use would diminish or prevent cracking, Mr. Shirley finds that such cracks are of so little importance that reinforcement would not be justified.

While various types of transverse joints have been tried on the Maryland concrete roads, Mr. Shirley now favors the entire omission of joints except at the end of a day's work. He finds it little, if any, more trouble to repair a transverse crack which forms across a road than to maintain a transverse joint. Where transverse joints are placed it is difficult to make the joint so smooth that it will not be felt when a car passes over it. Trouble has also been experienced where transverse joints are used with one slab rising above the adjacent one.

Although the commission believes in and favors the concrete road, other types of road are constructed, as account is taken of local prejudice in favor of one type or another and in some parts of the state it is difficult to obtain suitable sand for concrete except by a long haul.

Water-Supply of Panama Canal Under Operating Conditions

By R. Z. Kirkpatrick*

The year from September, 1914, to September, 1915, had the greatest water consumption for lock operation since the canal was opened. Except for a heavy rainfall and runoff in February and April, 1915, the inflow to Gatun Lake was about average during the year. The diagrams in Fig. 1 show the principal losses from Gatun Lake. Pumping for dredges and town water-supplies, leakages and seepage losses are too small to show on the scale. In December, 1915, pumping and leakages amounted to 29 and 15 cu.ft. per sec. respectively. Seepage is almost nothing. Normal leakages have been determined as follows:

Location	Area of Openings Closed by Gates, Sq.Ft.	Leakages, Cu.Ft. per Sec.
Gatun locks	11,990	5.93
Gatun spillway	11,410	3.64
Pedro Miguel lock	11,990	4.99
Miraflores locks	10,250	5.30
Miraflores spillway	5,520	0.86

These are very satisfactory values. Additional leakage occurs, however, when caissons are used instead of valves or gates. The original water-supply estimates allowed 275 cu.ft. per. sec. for leakage from Gatun Lake structures.

The water loss per lockage decreased later in the period shown in the charts, due to more crossfilling from one twin lock to another, use of 650-ft. lock lengths or passing more than one vessel in a chamber at a time. Use of water for lockage will increase of course with the growth of traffic. The locks are designed to permit 48 lockages a day, or 1,440 a month, but so far the greatest number of lockages a month was 182, at Pedro Miguel in July, 1915. Probably the maximum lockage requirements will not be reached for many years. The jump in the use of water for power in January, 1915, marks the beginning of all Isthmian power generation at the hydro-electric station. Before January, 1915, but one of the three turbines had been running. The original water-supply estimate of 275 cu.ft. per sec. for the hydro-electric plant did not anticipate the construction of auxiliary plants, such as coaling plants, dry docks, shops and relay pumps. About 1,000 cu.ft. per sec. is now used for generating power, and this figure is not the maximum to be expected.

Gatun Water Supply Ample

Experience so far indicates what was expected; namely, there is ample water-supply from the natural inflow to Gatun Lake, except in the dry season, when storage water must be used in part. With Gatun Lake at +87, from 5 to 7 ft. of storage, or 22.75 to 31.90 billion cubic feet is available before the depth is reduced enough to hinder shipping. The 1915 dry-season hydrology of Gatun Lake is shown in Table 1.

The total yield for 1914 was 102% of the capacity of Gatun Lake at +85; this is but a little more than the average yield. Careful hydrologies of Gatun and Miraflores Lakes and Chagres River watersheds are kept. Rainfall stations are located on various parts of Gatun Lake and along the line of the canal and extend up the Chagres as far as the Rio Culebra and Rio Indio, twenty-five miles above Gamboa. The estimated rainfall over Gatun Lake drainage area and watershed is calculated by averaging the monthly precipitation of adjacent stations and weighting the intervening section average with the section area. The general average of the weighted averages is the rainfall used in the hydrologies.

United States Standard Weather Bureau and tipping-bucket rainfall equipment is used, also the Friez automatic water-stage register. The latter is essentially a metal

*Assistant Chief Hydrographer, the Panama Canal, Balboa Heights, Canal Zone.

TABLE 1. RECORD OF GATUN LAKE HYDROLOGY, JANUARY TO APRIL INCLUSIVE, 1915

Gatun Lake:	
Dry-season mean elevation	86.81
Maximum elevation (Feb. 10)	87.20
Minimum elevation (Apr. 24)	86.32

	Quantities: Million Cu.Ft.	[illegible] Cu.Ft. per Sec.
Gatun Spillway:		
Waste	23,263.5	2,233.8
Leakage	37.7	3.6
Gatun Locks:		
Lockage and tests (492 lockages)	1,980.2	191.0
Leakage	61.5	5.9
Gatun hydro-electric plant	8,311.8	801.7
Pedro Miguel Locks:		
Lockage and tests (491 lockages)*	1,744.4	168.2
Leakage*	75.2	7.3
Pumping at Cucaracha slide*	97.0	9.4
Brazos Brook reservoir	118.0	11.4
Pumping at Gamboa	64.2	6.2
(a) Total outflow	35,753.5	3,448.5
(b) Storage (+ increase, — decrease)	—1,257.0	121.2
(c) Net yield (a + b)	34,496.5	3,327.3
(d) Evaporation on lake (24.31 in.)	9,427.5	909.3
(e) Total yield (c + d)	43,924.0	4,236.6
(f) Rainfall on lake (21.91 in.)	8,492.0	819.1
(g) Yield from land area (e — f)	35,432.0	3,417.5

	Mean Area, Sq.Mi.	Rainfall, In.	Runoff, In.	Percentage Runoff
Lake surface	166.9	21.9	21.9	100.0
Land area	1,153.1	19.2	13.2	69.0
Total watershed	1,320.0	19.6	14.3	73.0

* Into Miraflores Lake.

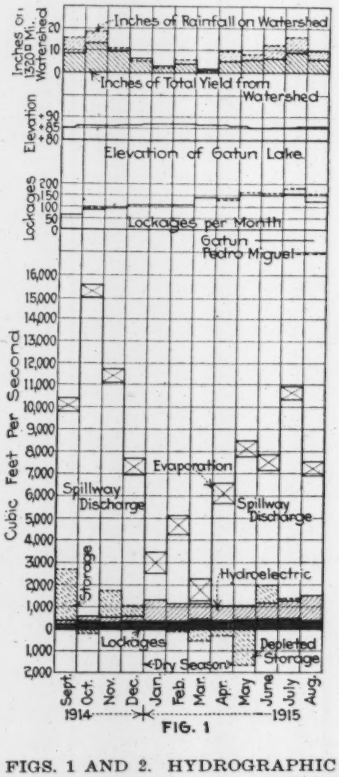


FIG. 1

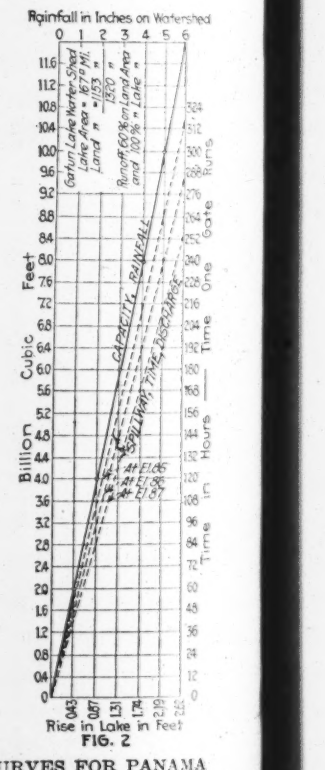


FIG. 2

FIGS. 1 AND 2. HYDROGRAPHIC CURVES FOR PANAMA CANAL

Fig. 1—Diagrams showing rainfall and runoff from Gatun Lake drainage basin; elevation of lake surface, number of lockages per month and outflow and losses from the lake. Fig. 2—Diagram showing effect of rainfall and spillway outflow on Gatun Lake level

float suspended from a tape and counterweighted over a sprocket wheel; a pen plots a hydrograph on the sheet on a drum that is geared to a clock; the drum has a common axle with the wheel. The more important water-stage register stations have daily sheets; the others are changed weekly. At Gatun and Pedro Miguel locks, Gatun spillway and Gamboa, concrete towers, lighthouse type, Fig. 3, were built for the water-stage instruments. These towers are equipped with anemometers recording wind directions and velocities. This arrangement is useful in studies of water-stage heights, currents and wind, giving permanent automatic records. Other water-stage instruments on sheltered wooden platforms are located up the Chagres River and along the lake for studies of freshet runoff. Juan Mina Lake station has recorded as high as a 1.5-ft. head above Gamboa; and Gamboa, 0.2 to 0.3 ft. above Gatun, during a Chagres River freshet.

Discharges at Gatun spillway channel and at Alhajuela are occasionally measured with single and penta recorder Price current meters; gagings are made from a gaging car, suspended from a cable. Lake or channel-current velocity gagings are made from boats at anchor. A Haskell-Richie current velocity-direction meter has given good results in charting channel currents.

Evaporation records over Lake Gatun are obtained from a copper pan, 4 ft. in diameter and 10 in. deep, floating in an open section of the lake. An anemometer for recording wind movement, a thermometer for water temperature and a standard rain gage complete the equipment. The pan is protected from waves by a wooden frame, properly buoyed. The station is so located to give lake conditions. The water in the pan is kept about 4 in. from the top, and the daily readings are corrected for precipitation. The average Gatun Lake evaporation is about 61 in. a year and is much heavier in the dry-season months and during daylight hours.

Gatun Lake Control

The control of Gatun Lake during freshets is handled so quietly that dredgemen and shipping in the lake usually do not know a freshet is in progress. A variation of 0.15 ft. in the lake elevation is commonly the maximum. A general rainfall over the whole watershed is exceptional, the common type being a sudden downpour in one section. The Chagres River section produces one-third of the outflow in a general rain, but is subject to more frequent local freshets. Flood-warning stations are located at Vigia and Alhajuela; a rising river warns the local observers by ringing an alarm bell. The flood-control hydrographer at Balboa Heights is in touch with the river stages through telephone reports at least each half-hour during freshets. From his rating curve it is known how much water is coming several hours before it reaches the lake. In like manner the flood-control hydrographer gets rainfall and lake-stage reports from most of the lake stations; from these data he gives telephoned orders for the opening and closing of the spillway gates at Gatun. His position might be called "water dispatcher." During the wet season it is exceptional if at least half an inch of rainfall does not occur at some place during each 24 hr.; prompt reports, day and night, are therefore necessary to operate the spillway intelligently.

Curves showing the rise to be expected from a given rainfall over a given watershed area, the probable yield resulting and the time taken by one spillway gate to waste

FIG. 3. WATER-STAGE RECORDING STATION AT GAMBOA

this yield are helpful in properly handling the spillway operation. For example, referring to the curve, Fig. 2, a general 5-in. rainfall on the whole watershed will yield 9,976 million cubic feet, produce a 2.2-ft. rise, and it will take one gate 317, 286 and 255 hr. at lake elevations +85, +86 and +87, respectively, to waste this water. It is necessary to let the water out about as fast as it reaches the lake, to prevent a rise of less than 0.15 ft. So far this has been done by the simultaneous operation of not more than six spillway gates with a maximum discharge of 71,340 cu.ft. per sec.

Calibrating Spillway Discharge

The Gatun spillway gates have been calibrated for discharge between El. 84 to 87. This was done by measuring the discharge by 44 current-meter gagings in the lower spillway channel. At lake El. +87 a gate opening is 18.11 ft. in depth by 45 ft. in length, which equals 815 sq.ft. These openings are very deep, broad-crested weirs. The photograph, Fig. 4, shows seven such openings discharging during a test. Average values of C in the well-known Francis formula $C = \frac{Q}{LH\sqrt{2gH}}$ were calculated from the measured discharges, and a rating curve and table were prepared. C has a value of 3.77 and 3.60 at El. 87 and 85 respectively. In designing an opening sufficient to waste 154,000 cu.ft. per sec. the designing engineers used a flat value of $C = 3$. Actually, the 14 gates will discharge $13{,}075 \times 14 = 183{,}050$ cu.ft. per sec. at +87, and with a possible 50,000 cu.ft. per sec. more wasted through the lock culverts at Gatun and Pedro Miguel locks, ample control of floods of record volume is assured.

Data on maximum current velocities due to Chagres River freshets have been obtained by current-meter measurements taken at 1-ft. depths at Gamboa bridge and are shown in Table 2.

The currents are at right angles to the Panama Canal channel, the bridge being just north of the east bank of the canal. The backwater of the arm of the lake extends about 8 mi. above Gamboa bridge. None of the freshets shown are as big as have occurred before the lake was formed, but the results are reassuring. Careful studies of incoming sediment above Gamboa bridge are impossible now. Gravel and sand for concrete and ballast on the Canal Zone are dredged from the old beds above Gamboa; this is a great advantage from the standpoint of economical construction, besides subtracting from the filling-up tendency. The 1-ft. depth freshet velocities are gratifying as to possible shoaling in the canal channel. Only very fine silt shows at the municipal-engineering intake

south Gatun Lake stations read 0.02 to 0.15 ft. higher in the afternoon than early in the morning. The opposite effect is noticed at Gatun, but not so marked, the lake falling from 0.01 to 0.05 ft. Considerable wave action is noticed along the shore line near the Agua Clara lighthouses, owing to the long sweep of the wind over the lake.

Surges are set up in Gaillard Cut when water is admitted to Pedro Miguel lock. Repeated valve operations are sometimes accidentally so timed as to cause harmonic increase to these surges. With various phases of movements of ships and dredges, lock-valve operations, opening and closing of the Paraiso pontoon bridge and wind direction, the surges become hopeless for study. That they do follow a given law is sure. The Pedro Miguel

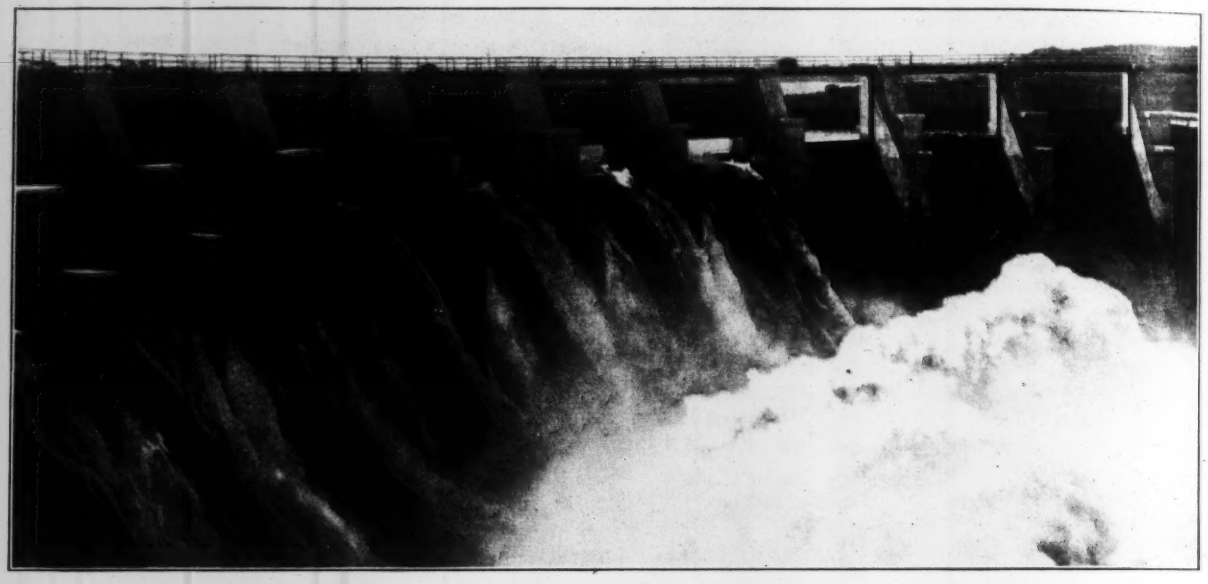


FIG. 4. DISCHARGE OVER GATUN SPILLWAY DAM WITH SEVEN GATES OPEN

and pumping plant, which leads to the Miraflores Filtration Plant, and is located just above Gamboa bridge.

Current velocities in Gatun Lake due to simultaneous discharge of four to five spillway gates show greater velocity at Bohio narrows, 9 mi. from the spillway, than in the canal channel, only ½ mi. from the spillway; 2,000

TABLE 2. CURRENT VELOCITIES IN GATUN LAKE

Date	Discharge in Cu.Ft. per Sec. Alhajuela	Gatun Spillway	Gatun Lake Elevation	Current Velocity in Ft. per Sec.	Mi. per Hr.	Knots
May 26, 1914	15,900	10,390	84.92	0.95	0.65	0.56
June 30, 1914	20,050	41,380	84.88	1.54	1.05	0.91
July 28, 1914	25,300	30,972	84.86	1.83	1.24	1.08
Aug. 22, 1914	21,600	20,905	84.97	1.61	1.10	0.95
Sept. 7, 1914	28,665	52,265	84.97	2.11	1.43	1.24
Oct. 7, 1914	31,200	70,680	86.10	2.11	1.43	1.24
Apr. 3, 1915	27,085	63,895	86.67	1.74	1.19	1.03

and 1,475 ft. per hr. at 1-ft. and 20-ft. depths at Bohio and 1,080 ft. and 730 ft. per hr. at 1- and 15-ft depths at about ½ mi. from the spillway are the records. Spillway discharge from five gates also caused a measured drift toward the spillway of 3,565 ft. to 1,510 ft. per hr. at 5- to 20-ft. depths along the east side of Gatun locks upper approach wall. Wind was blowing toward the spillway from 8 to 25 mi. per hr., the higher wind velocities occurring with the higher current velocities.

During dry-season months the trade winds blow steadily from a northerly direction and hardest during the day. The effect is that gage rods at Gamboa and other lockage surges are recorded at the Juan Mina and San Pablo water-stage instruments. During the lockage of the steamship "American Transport," northbound, Nov. 7, 1914, all conditions for a natural surge were typical. The time interval and amplitude of surge from crest to trough were observed as shown in Table 3.

TABLE 3. TRAVEL OF SURGE IN GAILLARD CUT

	At Pedro Miguel Lock Time	Lake Elevation	At Gamboa Time	Lake Elevation	At Juan Mina Time	Lake Elevation
Effect of opening valves started	11:40 a.m.	85.94	12:01 p.m.	85.95	12:25 p.m.	85.94
Trough of wave	11:45 a.m.	85.23	12:05 p.m.	85.82	12:30 p.m.	85.90
Crest of return wave	12:30 p.m.	86.60	12:45 p.m.	85.98	1:15 p.m.	86.00

Pedro Miguel lock to Gamboa is 9 mi.; to Juan Mina, 15 mi.

Current velocities, due to mixing of fresh and salt water, occur at the sea-level ends of Gatun and Miraflores locks. At 1-ft. and 2-ft. depths currents of 6 and 4.5 ft. per sec. at high tide of +8 and low tide of —7 respectively at the lower Miraflores locks miter gates have been found. It has been learned that after opening the gates there are (a) an upper fresh-water volume moving out to sea, (b) a neutral volume with no motion between the depths of 15 and 25 ft. from the surface of the water and (c) a lower salt-water volume moving into the sea-level lock chamber. The net effect of these currents is to hamper boats in picking up speed for leaving the locks.

Constant-Level Orifice Box Feeding Chemicals

By Weston Gavett*

One of the most important features of a water-purification plant where chemicals are employed is the apparatus for applying the chemicals to the water, but good automatic apparatus has not always been available because of its expense. The following notes describe a constant-level orifice feed box designed by the writer for a place where an inexpensive installation was required. The experimental box combines the features of two old types and performs so well that, if the idea should prove not to be new, it is unfortunate that the arrangement has not been more used.

The need of good semiautomatic feeding apparatus for small plants is real, and here the importance of an accurate application of chemicals is too often under-estimated. The nontechnical attendant has the impression that all is well if any coagulant at all is going into the water, while the tendency of the chemist in charge of a plant is sometimes to place too much importance on the laboratory control and overlook the mechanical end of the plant, where minor improvements may be rewarded by savings in operating cost and increases in efficiency.

With waters of excess alkalinity, it may be possible to use a considerable excess of alum and obtain good efficiencies from the purification standpoint, but economy suffers. These conditions are especially apt to breed carelessness in exact feeding. When the alkalinity is deficient and lime or soda ash is required, when iron sulphate and lime are used for coagulants or when using hypochlorite of lime, the great importance of adding the solutions exactly as desired needs no enlarging. Complaints due to taste from an excess of "bleach" and occasional decreases in the efficiency of sterilization are more apt to be caused by the poor chemical appliances than by an error of judgment of the operator in determining the amount that was supposed to have been used.

It is customary in most plants to check the amount of solution run by readings of the level of solution in the tank, using a float and scale, gage-glasses or recording gage. This plan gives an accurate and necessary check on the amount that has been run, but does not show the actual rate at any time. By throttling a valve on the feed line very good results are often obtained. A good filter attendant by constant practice may obtain surprising proficiency in estimating the flow. In fact, this method may give better results than with some orifice boxes. Such dependence on the human element, however, is not desirable.

The usefulness of an orifice box depends largely on two factors: (1) The method of maintaining a constant head; (2) the method of varying the size of the orifice. The general forms of boxes are the weir and the float-valve type. In the weir box the solution is pumped to the box, which is above the tank, and the excess is allowed to overflow a weir to the tank. The head obtained is practically constant, but the pumps and their upkeep are expensive. The float-valve type seems less desirable. A certain amount of variation of level is essential to the operation of a float valve, and in practice the actual variation greatly exceeds the theoretical amount, owing to clogging of the valve, lost motion, friction, etc. With a float valve a deep box is desirable to reduce the error from the variation of head.

The accompanying figures show a box devised by the writer to combine the advantages of the weir and float-valve types without their disadvantages. The operation of the box is shown diagrammatically in Fig. 1. The solution from the tank enters the main compartment, the largest part passes through the large orifice, and the excess overflows the weir into the small compartment. This excess is the amount that flows through the small orifice and is not wasted, but goes to the water with the solution from the main orifice.

The main compartment has a constant head at all times; so if a good orifice is used, the greater part of the flow is accurately applied. The variation in level caused by the float valve affects only the little compartment and the very small flow from the little orifice.

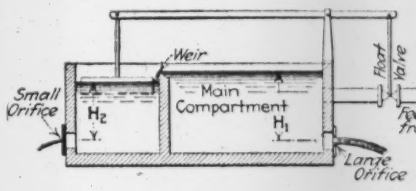


FIG. 1. DIAGRAM OF COMBINATION WEIR AND FLOAT-VALVE ORIFICE BOX

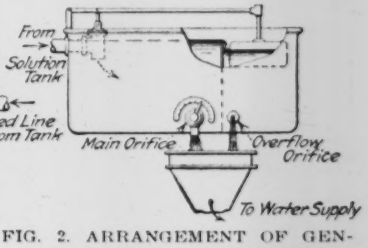


FIG. 2. ARRANGEMENT OF GENERAL SERVICE CONSTANT-LEVEL FEED BOX

In the experimental installation the available head was very limited, and only 7 in. could be used for H_2. The following compares its accuracy with the common float-valve type: Assume 90% of the flow from the big orifice and 10% from the little. Call the variation in H_2, due to the float valve, 1 in. The percentage error in the flow from the small orifice due to this variation is 7%. Thus 90% of the flow has an error of zero, and 10% has an error of 7%, or the mean error for the combined flow is 0.7%.

If still more accurate results are desired and the use of a pump is not objectionable, the smaller flow can be pumped back to the tank. This would require a much smaller pump than is needed for the common type of weir box. Fig. 2 shows a box of this combined type designed for general use. The points to be considered in design are: The little orifice should be as small as possible, but large enough to prevent serious clogging; the small compartment should be just large enough to contain the float and yet allow a free weir discharge; the large orifice may be of any good type. The writer prefers the use of separate orifices of constant size to the adjustable variety. With six orifices in the main compartment (0.5, 1, 2, 2, 5 and 10—the figures represent the proportions of the flows of the different orifices) and one in the float compartment (0.5) any flow from 0.5 to 21 could be obtained, increasing by increments of 0.5, or 42 different flows. In the experimental installation the solution tank was divided into 100 divisions, and the units of flow used for the orifices were divisions per hour. This method made a simple and convenient system for the attendants.

With accurately calibrated orifices of constant size clogging is apparent. With constant head and free orifice the flow is exact and there is no dependence on moving parts.

*312 West Fifth St., Plainfield, N. J.

Filing Correspondence in a Municipal Department

By Robert J. Fee*

In a municipal department there are changes in executive management with each city administration. This procedure is defended on the ground that the elective official must have in the different branches of the service lieutenants who will sympathetically carry out his political policies. Established office routine, however, that has been standardized and found efficient is seldom disturbed by the new appointee except, perhaps, to be strengthened. No matter what the administrative policy may be, a routine channel of checks is essential; and a tried methodical system already installed provides this. The scope of the present article is limited to the filing and indexing of correspondence.

The filing system is an essential detail of organization, and it must always operate satisfactorily. For instance, it is often imperative, as during hearings, to produce a document immediately; time cannot be spared for a prolonged search. It would seem a simple matter to file a letter under the subject of its contents, but upon consideration certain difficulties immediately appear. Suppose a letter, for example, treats of sureties, or some other question, directly concerned with a dozen contracts. The contracts become primarily concerned and then are of the most importance, since the matter may affect the payments thereunder. To file separate copies under the various subjects discussed or, in the case mentioned, under a dozen different contracts, is wasteful duplication, besides congesting the files, while to limit a communication to a single subject is poor economy.

Transfer from a Subject File to a Subject Index

The difficulty experienced in filing papers supporting the records of the proceedings of the Board of Water-Supply—a municipal department created to build the Catskill water-supply of the City of New York—was solved by Edward S. Brownson, Jr., assistant secretary, about a year after construction was inaugurated. The filing of documents according to subject had been found to be inadequate. The method adopted was to file by accession number, which was indexed on cards according to the previously established classification. The old subject list was thus continued, but was confined to the index, the papers themselves being distributed in the files under their various file numbers. An original paper can be filed in only one place, but it is an easy matter to point out this location by one or more directory entries in a card index.

No peculiarities of any elaborate and complicated scheme had to be worked out, and at once the progressive numbering system proved its superiority for an office handling a large enterprise. The method embodies economies of time and space by fixing a definite location for contents and by eliminating dead space, as growth occurs only at the end last added. No readjustment is necessary owing to expansion of any one subject, and the cabinets seldom used may be removed to less valuable space.

The principle of the serial-number plan is to stamp each new communication with a new accession number and catalog its contents in the index. When the answer comes along, it may, if strictly germane, be given the same number; but if the subsequent correspondence is prolonged and numerous reports are received, covering ramifications, each distinct step in the matter is given a new number. Each transaction thus becomes separate and is not confused with that which precedes or follows.

Use of the machine stamp in assigning a new number also saves time taken to look up previous records of the subject treated in the letter at hand and eliminates the possibility of a transposition or other error of transcription. Should, however, a paper be given a wrong number, it only means that the entries under two subjects will bear the same file number and that the papers of each will be filed together instead of separately—not a great sin when the papers are few.

Cards bearing subject headings are arranged in a single alphabet, on the plan of a dictionary. Entries are made in compact form, and where necessary, general and particular connecting references are given to topics more or less related. The making of interlacing references is elastic requiring judgment, according to the necessities of the case, to save repetition and needless extension and to weave a fabric that will enable the inquirer to trace the allied branches of a subject of which he has only a clue. Everything on a given topic is set forth in a tabular synopsis with distinctions between items, aided by different file numbers to lessen the labor of the investigator, should he desire to examine the correspondence on some particular phase of the group. The file number, then, points exactly to the few specific papers bearing it, in contradistinction to the subject number of other systems which refer to a great mass of matters bearing the same general subject name, but which may or may not be related to each other. With an index these matters appear under one heading on the cards, but are there analyzed and the file number used to narrow the limits.

A Matter Not Located Is Nonexistent or Lost

A glance through the cards on a given subject is sufficient to indicate whether a paper exists or a certain action has been taken. This avoids laborious search through files without result and the further mistrust that the data desired are not buried away in a report filed under some other subject. When a card catalog is intelligently maintained in connection with the files, information of this sort is brought out clearly. If a matter does not appear in the index, there is a fair amount of certainty that the matter does not exist; but in searching a subject file not checked by a supplementary index, all the searcher can say is that the matter cannot be located. Following is a sample of the entries under the subject indicated:

CONTRACT 423

	Date of Meeting		Page
See also Rondout Watershed.			
Printing authorized (57295)	July	1	536
Galley sent to Corporation Counsel (57364)	Sept.	9	755
Galley approved as to form (57364)	Sept.	16	777
Pamphlets sent to Corporation Counsel (57631)	Sept.	23	798
See Real Estate, Rondout, Section 7, Parcel 221 (57718).			
Pamphlets approved as to form (57631)	Oct.	14	838
Advertisement ordered (57821)	Oct.	21	890
Advertisements placed (57821). Copies filed with Comptroller (57903)	Oct.	28	913
Bids opened (60014). Referred to Secretary	Nov.	11	957
Report on bids (60014) referred to Committee of Whole	Nov.	18	975
Awarded to A. B. Smith Co. (60150)	Dec.	2	1011
Notice of award given (60150). Deposits released (60217)	Dec.	9	1036
Delivered, filed, notice to commence work given and engineer notified (60383)	Dec.	16	1054
Registered and Comptroller's certificate indorsed (60469)	Dec.	23	1079
See Police (60471)	Dec.	23	1083
Pauper bond filed with Newtown (60584)	Dec.	30	1092

*Indexer of Board of Water-Supply Records, New York City.

The first cross-reference, "See also Rondout Watershed," probably refers to the preliminary stages of the work before it had advanced sufficiently to be embraced in a contract and given the designation 423. Under the heading "Rondout Watershed" there is a reference to the authorization of the contract. The next cross-reference, "See Real Estate, Rondout, Section 7, Parcel 221 (57118)," evidently refers to some matter indirectly concerned with the contract, probably the acquisition of property. A file number is given in this case, making it more restrictive and limiting the searcher's examination to the entries under the parcel mentioned that bear this file number, disregarding all others as not pertaining to the matter at hand. In this respect the reference is more definite than a general reference. The next, however, "See Police (60171) Dec. 23—1083," is still more specific, as the whole matter is included in the minutes of a single meeting and described on page 1083 under the heading indicated.

It probably suggests itself to the reader that all cross-references should be similar to this last illustration. The answer is that it is simply a question of economy and how much detail is desired. As a rule, blanket references are never made to the general mass of matters under a subject where the file number, and if possible the date of meeting with its folio, can be given in addition to the subject. Where the information is strung over an extended period, the meeting date is left out; and if the file numbers are many, so as to make the reference almost general in character, they too may be omitted.

Under the names of the various bidders we also make a brief notation, as "Bidder for Contract 423 (60014) Nov. 11—957," and under the contractor's name the additional entry, "Awarded Contract 423 (60150) Dec. 2—1011." Cross-references would also appear under the name of any complainant or person in whose favor a payment warrant is ordered. The hanging indention is used to save repetition, and the cataloger's method of underscoring to indicate further indexing may be adopted to advantage. It will be noticed that the entries under the subject are arranged in chronological sequence. This is necessary owing to the difficulty of selecting an alphabetic keyword, although an attempt is made to choose a characteristic or significant catchword to begin the modifying-phrase entry. One of the tests of efficiency is preparedness, and liberal cross-references secure this and add to the utility value of the index. If there were no other reason this would be sufficient to justify the use of cards.

Dewey System Not Practical; Simpler Classification Better

In the case of the Board of Water-Supply proceedings an index to the minutes is an index to the files, the only addition required for the former being the date of meeting and page citation where a digest of the matter can be found. In many cases the index alone supplies all the information desired on a given subject in condensed form, so no consultation of files or minutes is necessary, since the entries under each heading form a continuous though skeletonized narrative. The index is printed annually and distributed to those receiving the proceedings.

The Government Commission on Economy and Efficiency, which approves of the Dewey decimal system of classification, says of the numerical system: "It merely enables the file clerk to get hold of particular letters, but it does not gather papers on the different branches of a subject. If all papers bearing upon a matter are desired, they must be searched for under various heads in the card index." In reply to this we would say that ordinarily it is a direct advantage to find a particular paper so easily instead of having to seek it in an unwieldy file of related papers. Generally, it is the specific document that is sought for complete information, as the gist of all papers on the matter under consideration appears on the card index. To bring the papers together in the files is therefore unnecessary, especially if the disadvantage of a bulky file is to be avoided. It is better to give a new accession number to each distinct step in the matter, distributing the papers over a wide range of pigeon-holes, as it were, and connecting these in the finder or index.

In the Dewey system the headings are likely to be too comprehensive or carried to too great detail; matters are filed within the restricted limits of the ready-made classed catalog and not to suit the convenience of the inquirer—the square peg behind being made to fit the round hole. Under this method a letter treating of two or more subjects is filed under one, with sheets containing references to the original letter under the related headings. With the accession plan the index entry simply is repeated under each heading and the paper is produced directly.

Subject List—Headings and Their Subdivisions

The searcher is not interested in the alleged scientific arrangement of the catalog's classification; he is only concerned in securing certain material. Of course, with the numbering plan an effort is made to be consistent, but the process is followed only so far as uniform methods help clearness and assist the user. As an aid in this direction the index is compiled or edited by one person, so as to secure adherence to the subject list and to avoid having different headings for synonymous subjects with no connection shown, as occur in Poole's "Index to Periodical Literature" and other large works. For as a single exception disproves the universal statement, so the one error in an index shakes confidence in the whole work.

The following brief subject list will give an idea of some of the larger headings: Accidents, accounts, agreements, civil service, claims, investigations, leases, legislation, permits, police, real estate and supplies. Most of these larger headings are subdivided, as under accidents we enumerate the various contracts, the general matters being set down on the first card without a subhead. The primary headings agreements and contracts are subdivided in the same way. Leases are distinguished from one another according to geographic location of premises; real estate is refined into sections and parcels, and supplies according to kind, while the civil-service class is subdivided into titles followed by the name of the employee. Thus the employee's record is always ready for inspection to date, as well as an outline history of any parcel of real estate, lease or contract, making the keeping of such additional records unnecessary.

Unit cabinets for vertical filing are used, and metal-tipped guide cards are inserted every 100 numbers. Manila folders have also been found to help to prevent post cards and the like from lodging horizontally on the floor of the drawer or slipping through the block slit. The drawers may be arranged to hold 1,000 file numbers, so that the location of, say, 44215 is drawer 44, folder 2. The index cards are kept in tray cabinets with screw rods

hat lock in the cards securing them against being easily removed, misplaced or lost.

The charging of a paper from the files is a simple business operation. When a paper is borrowed, an "out" card is filed as a receipt under the file number of the communication. Accordingly, when the loan is returned, the "out" entry is canceled in the borrower's presence. All papers must be charged in this library fashion. The person charged is held responsible, for he is requested to see that credit is given for papers returned. If outstanding papers are not renewed in a reasonable time, a notice is sent to the borrower. No person is permitted to remove papers from the files when it is possible to notify one of the filing clerks, and under no circumstances must papers be replaced in the files by other than the person assigned to that duty

Spruce Piles Cannot Stand Compacted Gravel

By Charles T. Main* and Henry E. Sawtell

In deciding upon the character of foundations to be used for the new buildings of the Massachusetts Institute of Technology, Cambridge, we found it necessary to take a great many borings. In much of the work the variation from one point to another was so rapid that repeated tests were made. Not only were borings taken and the conditions analyzed, but also a considerable number of test piles were driven, tested for load-bearing capacity and then pulled to observe the effect upon the point of the pile. It was decided that spruce piles would not be satisfactory under the existing conditions and that oak or some other hard material would have to be used.

The block plan of the group of buildings, Fig. 1, indicates the locations of 70 test borings, which are numbered chronologically. This chart shows the locations of the five spruce piles represented by the accompanying photographs. Many more piles were driven than those thus located, but a study of the character of the soil as given in the chart will throw some light upon the effect the different strata had upon the points of the piles.

The cross-sections through selected borings, Fig. 2, are quite illuminating. It will be noticed that the glacial deposit of sand, with some gravel lying immediately above the clay, shows a great variation in thickness, sometimes tapering to almost nothing. The variation in thickness of this deposit is from practically zero on boring No. 12, near the northwest corner of the building, to 29 ft. 5 in. in boring No. 22, under the west wing of the building, located only 330 ft. from No. 12.

The clay found under the glacial gravel was remarkable for its uniformity. It was only slightly plastic, being neither stiff nor soft, except in a very few places. It was devoid of excess moisture and almost free from a hard crust. In spite of this favorable condition, however, practically all the spruce piles driven down into the gravel were found upon pulling to be badly broomed or both broomed and broken. Because of this fact the load tests made on a few of them were inconclusive and could not be relied upon as guides in designing the footings.

Spruce pile No. 5, for instance, shown at the left in Fig. 3, was driven with a 2,300-lb. hammer. This pile had a 6-in. tip and an 11-in. butt. It showed an average settlement during the last few blows of 5/8 in. per blow under an average hammer drop of 6 ft. 2 in. Under these conditions the load value, according to the *Engineering News* formula $P = \frac{s+1}{2Wh}$, was 8.77 tons. This pile passed through about 9 ft. 7 in. of loose sand, silt, shells and black mud and penetrated the coarse sand and gravel about 61 in. When pulled, it was found both broomed and broken a little above the top of the gravel. This pile was tested under load and showed a settlement of only $\frac{1}{32}$ in. with 6.8 tons. For increasing loads, however, it settled quite rapidly until $\frac{7}{16}$ in. was reached under 18 tons and more than 1 in. under 20 tons. The pile showed a marked tendency to get out of plumb and was wholly unreliable as a guide.

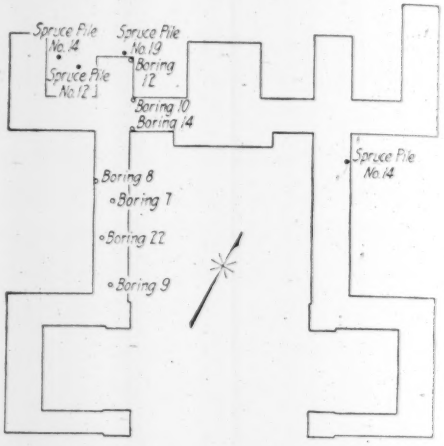


FIG. 1. BLOCK PLAN OF BUILDINGS, SHOWING LOCATION OF TEST BORINGS

Another spruce pile, which had a butt diameter of 10 in., with a 6-in. tip, and which was 18 ft. 4 in. long, was

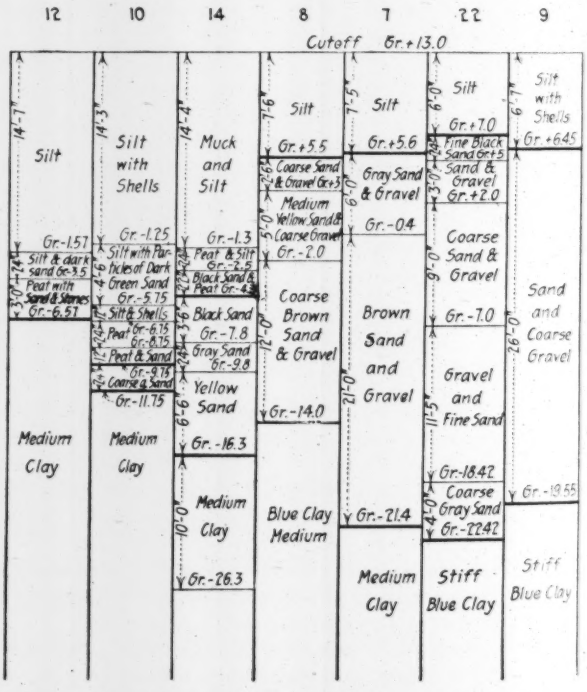


FIG. 2. CROSS-SECTIONS THROUGH SOME OF THE TEST BORINGS

*Consulting Structural Engineer and Mill Architect, 201 Devonshire St., Boston, Mass.

driven with the same hammer as No. 5, and during the last blows showed an average settlement of 1¾ in. under a drop of 10 ft. This gives a carrying value of 8.4 tons. This pile, which afterward was found broken and broomed below the top of the gravel, passed through 9 ft. 2 in. of loose sand, gravel, shells and mud-fill. It had penetrated the glacial gravel deposit about 5 ft. 9 in. After settling ⅛ in. with a load of 3 tons the rate of settlement of this pile became quite rapid, amounting to more than 1 in. with 15 tons and more than 3 in. with 32¾ tons. The effect of the brooming is shown by the recovery of ½ in. after the load was removed.

These tests made it quite evident that spruce piles could not be driven with safety into the harder portions of this glacial deposit. After studying these results for a number of test piles driven, it was decided to limit the use of spruce to those places where dependence had to be placed largely upon friction for bearing value, for it was plain that little dependence could be placed on point bearing. The tests showed, furthermore, that spruce piles which appeared satisfactory to the piling foreman and the inspector were, after driving, broken and broomed near the point. Thus it was out of the question to use spruce where sudden changes in the hardness of the soil were found or were to be expected.

At the same time, tests indicated that first-class oak piles could be driven without injury into well-compacted coarse sand or fine gravel to a resistance giving a bearing value of 18 tons or more. For this reason oak piles were used for the foundations where the driving was hard and where the supporting value was to be obtained largely from point bearing and relatively small penetration in the hard stratum.

The assumption was made that if any settlement occurs on this site, owing to the weight of the buildings, it will be in the clay. To reduce this settlement to a minimum, it was decided to spread out the building loads over the glacial gravel as much as possible. This practice was depended upon to extend the loads still further over the clay bed. As it was desired to provide for the wide distribution of load on the gravel in the most uniform manner, with a resulting low pressure per square foot, it was decided to use a large number of wooden piles, each sustaining a relatively small load, rather than a few heavily loaded piles. This condition made it inadvisable to use concrete piles.

FIG. 3. DISTORTION OF SPRUCE TEST PILES CAUSED BY DRIVING IN DIFFICULT GROUND

Co-operation of Engineering Activities by States

A single engineering association for each state, representing all the engineering organizations within that state, was one of the plans suggested at the recent conference on engineering coöperation in Chicago.

Under this plan, presented by Paul Hansen, Chief Engineer of the Illinois State Board of Health, all effort to maintain a professional classification would be abandoned, and the state and local societies would be opened to all engineers. Instead of being devoted primarily to the presentation and publication of papers of a technical character they would be devoted to promoting engineering activities. This would include not only general activities, but even specific improvements, such as a new road, river improvement or land-reclamation project.

This may be accomplished, in Mr. Hansen's opinion, by the state engineering society encouraging the formation of sections, largely autonomous in character and devoted to any idea or purpose in which engineers may be interested. These sections should admit to their membership not only engineers but others interested in the subject or project which the section was formed to promote. It is not advisable that persons not engineers should be admitted to membership in the society, but merely to the section, for which privilege a nominal fee may be charged. City engineers' clubs might also constitute sections of the state societies.

Economy of Continuity in Reinforced Concrete

By Raymond J. Roark*

An interesting theoretical study of the relative economy of continuous and noncontinuous reinforced-concrete girders can be made on the basis of average maximum moments and shears. By making use also of the maximum moments and shears a way is provided for making rapid estimates of the amounts of steel and concrete required in any given case. This method, as discussed herewith, is particularly applicable to the reinforced-concrete viaduct of girder type, where the quantities involved are such as to warrant detailed analysis and relatively accurate design.

The quantity of steel required as reinforcement against bending will first be considered. Assuming a constant-moment arm for the steel, the area of reinforcement at any section of the beam is proportional to M, the maximum bending moment at that section. Hence, the volume of steel required in any span is proportional to the average maximum moment in that span. Now, for any given type of beam and loading, M can be expressed in terms of x, the distance from the left end of the span to the section in question, and the total load on the beam. The evaluation of $\frac{I}{L}\int_o^L M dx$, where L is the span, will then give the average maximum moment desired.

In the following analysis two kinds of loading will be considered—a load W uniformly distributed over the span (hereafter referred to as the dead-load) and a single concentrated load P placed for maximum effect (hereafter referred to as the live-load).

The average moment due to dead-load is readily found, and the work will not be given here. The average maximum moment due to live-load is also easily found for a beam simply supported at both ends, but in the case of continuous or fixed-end beams the problem is much more complex. Here the moment at any section is a function, not only of x, but also of k, where kL is the distance from the left end of the span to the load P. It is therefore necessary to find, in terms of x, that value of k for which the moment at any section is a maximum and thus express M in terms of x and P alone. It is also necessary to consider both positive and negative moments and to take into account, in the case of continuous beams, the effect of loads in spans other than the one in question. Furthermore, allowance must be made for the balancing effect of the dead-load, the ever present dead-load moments neutralizing, over part of the beam, the live-load moments of opposite sign. By assuming various ratios of P to W this can be done and the average maximum moments due to combined dead- and live-load thus found.

The method of analysis can best be explained by discussion of a particular case. The middle span of a continuous beam of three equal spans will be considered. Fig. 1 shows the diagrams of maximum live-load moments; positive moments are plotted above, negative moments below, the axis. The solid-line curves represent moments caused by a load P placed for maximum effect and in the span in question. The broken-line curves represent moments caused by a load P placed for maximum effect and in the two end spans. The equations of the various curves were found in the manner already indicated. Thus for the case in hand, the equation of moments for a load P acting in the span is

$$M = -\tfrac{1}{15}PL\,(7k - 12k^2 + 5k^3) + Px - \tfrac{1}{15}Px\,(10k + 15k^2 - 10k^3)$$

This is found to have its greatest negative value when

$$k = \frac{-(24L-30x)+\sqrt{(24L-30x)^2+4(30x-15L)(10x+7L)}}{2\,(30x-15L)}$$

Substitution of this value in the moment equation gives the equation of maximum negative moments, represented by the two solid-line curves below the axis in Fig. 1.

The upper diagram of Fig. 2 shows the curves of Fig. 1 combined into a curve of maximum positive live-load moments and a curve of maximum negative live-load moments. The lower diagram represents, to the same scale, the moments due to an evenly distributed dead-load W per span, W being, in this case, equal to P. These dead-load moments reduce the live-load moments, as indicated by the dotted lines in the upper diagram. For the span under consideration the average maximum live-load moment was found to be $0.2110PL$. The correction, found by dividing the shaded area in Fig. 2 by L, is $0.025PL$. The average dead-load moment is $0.0316WL$. Hence, the resultant average maximum moment is

$$0.2110PL - 0.025PL + 0.316WL$$

which can be written, since W and P are here equal, $0.1088\,(W + P)L$.

Proceeding in the foregoing manner, the determination of the average maximum moment can be made for various ratios of P to W and for various types of beams. This has been done for values of $P \div W$ from 0 to 10 and for three types of beams—a beam simply supported at each end, a beam fixed at each end and a continuous beam of three equal spans. Values of the coefficient of $(W + P)L$ for average maximum moment have been plotted against corresponding values of the ratio $P \div W$, and the resulting curves are shown in Fig. 3. The results for the extreme cases of all dead-load and all live-load are given in Table 1.

A considerable amount of steel is usually required in the form of excess length, to provide for bond, and in the form of vertical or inclined stirrups, to provide for diagonal tension. Since both bond stress and diagonal tension stress are proportional to the vertical shear, the amount of steel so required may be regarded as proportional to the average maximum vertical shear. The value of this average maximum shear has been found for each beam for dead-load alone and for live-load alone. The

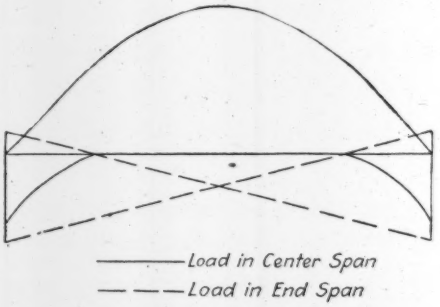


FIG. 1. MAXIMUM LIVE-LOAD MOMENTS

*Instructor in Mechanics, University of Wisconsin, Madison, Wis.

method is similar to that used in the determination of the moments, the shear S being expressed as a function of x and the load, and the value of $\frac{I}{L}\int_o^L S dx$ determined. The results are given in Table 2.

The cross-section dimensions of the girder will in general be determined by either the greatest bending moment or the greatest shear occurring in any span. Table 3 gives the values and positions of the maximum moments and shears for the beams under consideration.

Discussion of the Results

The results given in Table 1 show that the average dead-load moment for the continuous beam is $0.044WL$, while for the simple beam it is $0.0833WL$. For a uniformly distributed load it would thus appear that the continuous beam required but 53% as much steel as would a series of three simple beams of equal span. For a single concentrated load the advantage is the other way, the average maximum moments being $0.1989PL$ and $0.1660PL$ for the continuous and simple beams respectively. The former therefore requires 119% as much steel as the latter. For combined dead- and live-load the

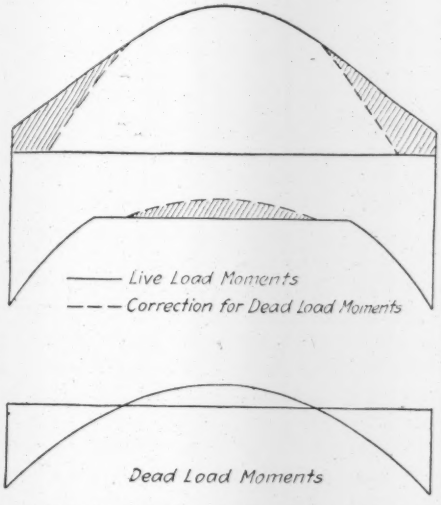


FIG. 2. COMBINED DEAD- AND LIVE-LOAD MOMENTS

moments increase rapidly for both beams as the ratio $P \div W$ increases; but as shown by the curves of Fig. 3, the increase is more rapid for the continuous beam. The curves cross when $P \div W$ becomes equal to 2.6 approximately.

The average moments are much smaller for both dead- and live-load in the case of the beam with fixed ends, and this is true for all values of $P \div W$. This would seem to show that, so far as primary stresses alone are considered, an increase in the number of continuous spans would result in a saving of steel.

The values in Table 2 show that the average shear is less for the simple beam than for either of the others. A somewhat smaller quantity of web reinforcement might therefore suffice, but the difference would be slight.

Table 3 shows that for any combination of dead- and live-load the greatest moment in a simple beam is greater

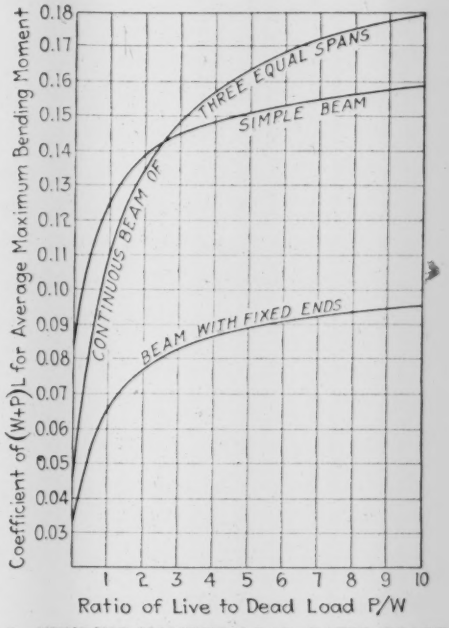


FIG. 3. BENDING-MOMENT LOAD RATIO DIAGRAM

than that in a continuous beam. Since the floor slab is generally an integral part of the girder, the effective section is that of a T-beam throughout in the case of the simple beam, while in the case of the continuous beam there is a T-section for positive moments and a rectangular section for negative moments. The large negative moments at the supports will therefore probably call for a greater width or depth of section than will the somewhat larger positive moment at the middle of the simple beam. If the dimensions of the girder are fixed by considerations of shear, the simple beam again has the advantage. Assuming the same average unit vertical shearing stress, the section of the continuous beam would have to be from 13% to 20% larger than that of the simple beam.

The average and maximum moments and shears can be used to estimate very quickly the approximate amount of concrete and steel required for any girder of given span and specified loading. The section can be readily determined from the maximum moment or the maximum shear, depending on which governs in the particular case,

TABLE 1. VALUE OF AVERAGE MAXIMUM BENDING MOMENT

Kind of Beam	For Uniformly Distributed Load W per Span	For Concentrated Load P per Span
Simple	0.0833 WL	0.1667 PL
Fixed-end	0.0321 WL	0.1019 PL
Continuous (end spans)	0.0316 WL	0.2110 PL
Continuous (middle span)	0.0521 WL	0.1929 PL
Continuous (average)	0.0431 WL	0.1989 PL

TABLE 2. VALUE OF AVERAGE MAXIMUM VERTICAL SHEAR

Kind of Beam	For Uniformly Distributed Load W per Span	For Concentrated Load P per Span
Simple	0.250 W	0.750 P
Fixed-end	0.250 W	0.813 P
Continuous (end spans)	0.250 W	0.834 P
Continuous (middle span)	0.260 W	0.817 P
Continuous (average)	0.256 W	0.823 P

TABLE 3. MAXIMUM MOMENTS AND SHEARS

Kind of Beam	Maximum Positive Moment — Magnitude	Maximum Positive Moment — Position	Maximum Negative Moments — Magnitude	Maximum Negative Moments — Position	Maximum Shears
Simple	0.125 WL + 0.250 PL	Middle	0	.....	0.50 W + P
Continuous	0.080 WL + 0.214 PL	End span	0.10 WL + 0.183 PL	Supports	0.6 W + 1.08 P or 0.5 W + 1.128 P
Fixed-end	0.0417 WL + 0.125 PL	Middle	0.0833 WL + 0.148 PL	Ends	0.5 W + P

and the amount of longitudinal reinforcement can then be computed on the basis of this section and the average maximum moment. Similarly, the average shear can be used as a basis on which to estimate the quantity of steel required in the form of bent-up bars and stirrups.

It is of course apparent that the foregoing discussion is based on certain more or less extreme assumptions as to the distribution of the reinforcement and the nature of the loading and that it fails to take any account of a number of factors any one of which may, under certain circumstances, prove to be of governing importance. Thus the question of settlement, or that of secondary stresses, might be so important as to neutralize the theoretical economy of the continuous form of construction in one case, while in another, considerations of rigidity and convenience in construction would warrant preference being given to monolithic design without regard to either economy in material or accuracy in stress determination. Such questions, however, can be discussed quantitatively only with reference to particular cases, where all conditions are known. The value of the theoretical analysis given depends of course upon how nearly the actual conditions approximate those assumed. For a case such as that of a bridge of girder type, carrying heavy street traffic and accurately designed for maximum shears and moments, it is believed that the results obtained may be regarded as fairly indicative of the relative economy—in material—of the types considered.

Eight Plate-Girder Spans Over Gila River Washed Out

The January floods caused many washouts in Arizona and California on both the Southern Pacific and Santa Fé railways, but perhaps no more serious washout occurred than the failure of eight 70-ft. deck plate-girder spans of the Gila River bridge of the Arizona Eastern R.R., a subsidiary of the Southern Pacific. The bridge is on the branch connecting the main line of the Southern Pacific at Maricopa with Phœnix, Ariz. This railway was constructed about 15 years ago and during its first years of operation crossed the Gila River on a pile trestle east of its present crossing (Fig. 2).

The Gila River has the reputation of being even more wily and uncontrollable than the Colorado. It rambles around through a very wide bed of fine sand and silt, and each flood develops new and unexpected channels. As shown in Fig. 2, the real river bed at the railway crossing is nearly a mile wide. The original trestle crossing was 3,800 ft. It was out of the question to build a permanent bridge of that length on a railway of this character. Parts of the trestle were washed out several times during the period it was in use.

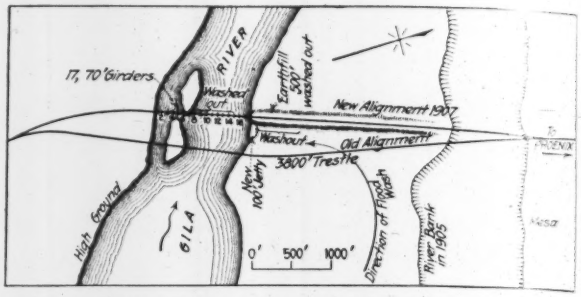


FIG. 2. LAYOUT OF GILA RIVER CROSSING OF ARIZONA EASTERN R.R.

A deck plate-girder bridge of a type extensively used on the Southern Pacific in the Southwest and in Mexico was constructed in 1906 and 1907. There were 17 spans of 70 ft. each, making a total length of bridge of approximately 1,200 ft. The girders are of a standard type fabricated by the American Bridge Co. The two end abutments are of concrete masonry. The south abutment rests on piles extending to bedrock, but at the north end no rock was found. The piers each consist of two 6-ft. steel cylinders filled with concrete resting on piles. The cylinders are braced for the upper 12 ft. with solid steel webs held in place by angles riveted to the cylinders.

They were sunk in the river bed as open caissons. The bottom section is 3 ft. deep, the second 4 ft. 8½ in., the third, 6 ft., the fourth 7 ft. 1½ in. and the fifth 7 ft. 1 in. deep, making the depth of the cylinders practically 28 ft. Piles were driven in the river bed, averaging eight to each cylinder, extending to a depth about 30 ft. below the bottoms of the cylinders. The first seven piers and abutment as numbered (1 to 7) were founded on piles that reached bedrock, but all the others ended in the sand and silt of the river bed, which extends to unknown depth. There are occasional pockets of gravel.

The piles extended up into the cylinders to within 7 ft. of their tops. The space between and around the piles was filled with concrete; and the top 7-ft. section of the cylinder, which is all that stands above low-water level, was filled solid with concrete. The base plates of the girders rest on cut granite caps.

The flood of Jan. 18 and 19, 1916, was apparently no greater than that of 1907, which occurred during the construction of the bridge. The damage recently done is laid to the vagaries of the river rather than to any lack of foresight. The old trestle piles, shown in Fig. 3, caught much of the floating débris and acted for a time as a dike or jetty. It eventually gave way; but in the meantime the current formed a new channel around the north end, so that nearly the full force of the flood sideswiped the approach embankment on the north and struck the bridge piers near that end broadside instead of on their narrowest face. The piers have

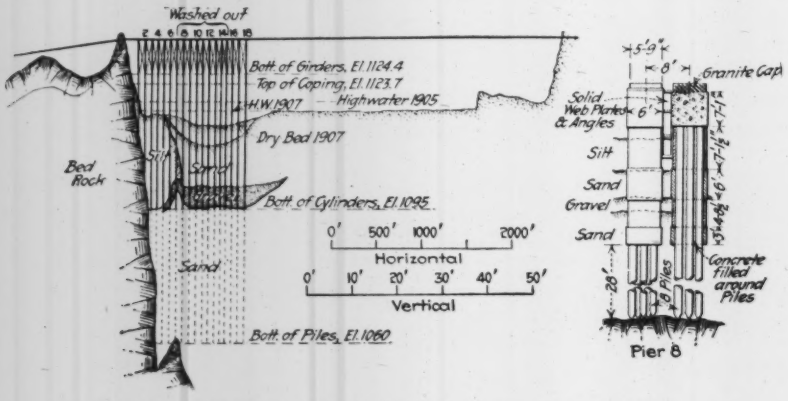


FIG. 1. PROFILE OF CROSSING AND DETAIL OF PIER

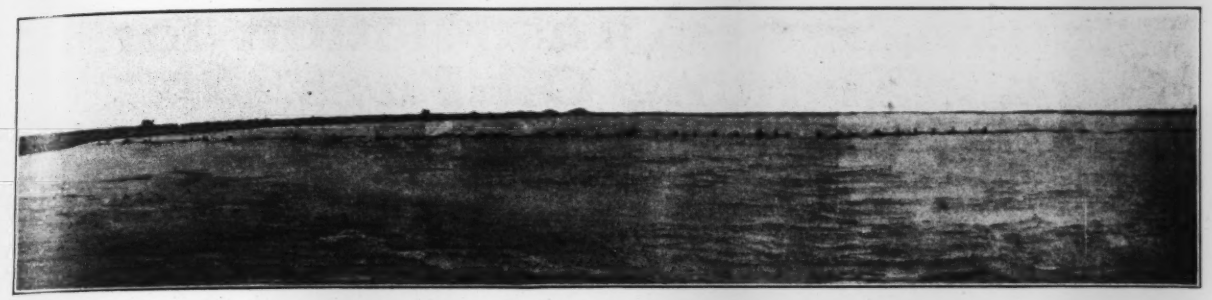


FIG. 3. LOOKING OVER SITE OF BRIDGE AFTER WASHOUT

of course not much resistance to overturning from a pressure in this direction.

It appears, however, from a statement by C. M. Scott, Superintendent at Phœnix, who saw some of the spans go out, that the piers did not fail by overturning, but from scour. It is said that the water rushing under the web bracing scoured so deeply that the piers simply dropped down out of sight. There is no trace left of a single one of them. Two of the eight deck girder spans are in the river some 200 to 500 ft. below the bridge. They are apparently undamaged, and an attempt will be made to recover them. Others may be located during the placing of the foundations for the new piers. One of the two located spans may be noted in Fig. 6.

Proposed Method of Reconstruction

It is proposed to reconstruct the eight spans on concrete piers. Interlocking steel sheet piling will be driven in the river to a depth of 30 or more feet, and the interior of the caisson thus formed will be excavated. Piles will then be driven to a depth of approximately 30 ft. below the bottom, as before, and the interior of the caissons will be filled with concrete, leaving in the steel piling as forms. The bases of these piers and of the existing piers at the river bottom will be surrounded with large stone riprap to take care of scour, the idea being to use stones large enough to hold their places and drop down in case of under-scour.

Besides the loss of eight bridge spans, about 500 ft. of the embankment at the north end of the bridge was washed out by the sideswiping action of the flood waters. The remainder of the fill was saved only by the use of brush and wire mattresses. These were made of Page wire fencing laid out on the rails and woven full of brush. The mats were then laid on the face of the fill and weighted with stone and rails.

The railway traffic was interrupted for about a week, during which time pile trestles were built across the breaks. The fill has been replaced and the toe of the embankment protected with large-sized riprap. As an additional safeguard against another flood's sideswiping the embankment a short jetty, about 100 ft. long, made of large pieces of stone, is to be built at right angles to the fill at the end near the bridge abutment.

For the data and some of the illustrations in this article *Engineering News* is indebted to L. H. Long,

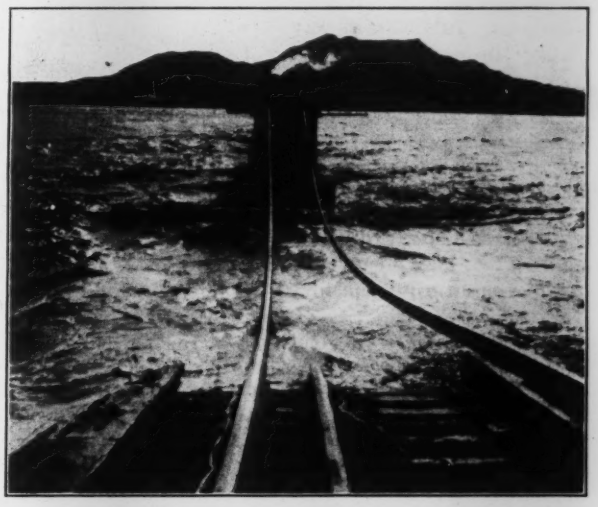


FIG. 5. JUST AFTER FIRST SPAN WASHED OUT

Vice-President and Chief Engineer, C. M. Scott, Superintendent, and L. M. Hitchcock, Division Engineer, of the Arizona Eastern R.R. The reconstruction pictures were taken by a member of the staff, Mar. 18, 1916.

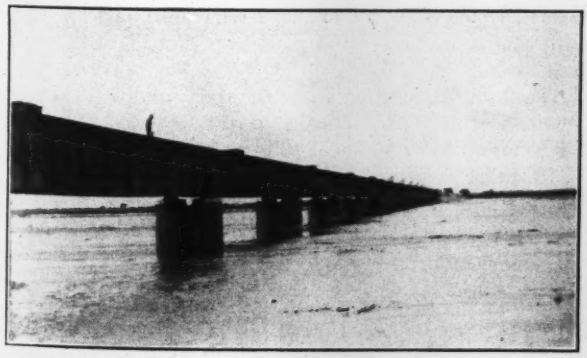


FIG. 4. LOOKING NORTH TOWARD TEMPORARY TRESTLE IN BACKGROUND

FIG. 6. ONE OF THE LAST SPANS IN ITS PRESENT RESTING PLACE

Foam-System Installation for Fighting Oil Fires

By C. P. Bowie*

SYNOPSIS—Protection of oil-storage tanks from fire by use of foam extinguishers. Formulas for solutions. Details of plant installed at Coalinga, Calif.

The foam system of fighting oil fires consists essentially of bringing together two chemical solutions, which on combining produce a thick tenacious foam, and of spreading this foam over the surface of burning oil, thereby excluding the oxygen of the atmosphere and hence extinguishing the flame. The practical application of the scheme to a concrete case is described in the paragraphs that follow. This process, so far as can be determined, is of German origin; its possibilities as a fire extinguisher for highly inflammable hydrocarbon compounds are said to have been first demonstrated in the fall of 1905 at one of the government laboratories at Hamburg. In 1909 it was reported upon by United States Consul T. H. Norton, of Chemnitz.

For a great many years it has been the practice among oil companies in the United States to protect tanks and reservoirs used for the storage of crude as well as refined oils, by a system of steam piping so arranged that in case such a receptacle is struck by lightning or otherwise ignited, the space between the surface of the oil and the roof can be quickly filled with steam. If the roof remains intact long enough for the steam to fill all of this space, such an arrangement will usually put the fire out. However, in the majority of cases where a storage tank or reservoir catches fire, the gas above the surface of the oil will explode and so badly shatter the roof that efforts to smother the flames with steam are useless. So it is that the foam system, having proved its adaptability to this class of fire-fighting, is rapidly being installed at storage "farms" and refineries of many of the larger oil companies and bids fair to be generally accepted.

The apparatus required for the practical application of such a process consists of two tanks—one for each of the chemical solutions—a suitable pump, pipe lines to carry the solutions to the oil tanks or reservoirs, mixing boxes where the chemicals can be combined and a means for properly distributing the foam.

In general the solutions for producing the foam may consist of any two compounds which, on coming together, will form an abundance of relatively tough bubbles, the inflating gas of which is itself noninflammable. The chemicals used must be fairly cheap; also they must be of such a nature that they will not deposit any appreciable amount of sediment after having been in solution for a long period of time. Each of the accompanying formulas has given satisfactory results.

In all the formulas solution A and solution B are to be combined in equal parts to produce a maximum amount of foam. The usual test is to pour 50 c.c. of solution A into a graduated tube and 50 c.c. of solution B into a similar tube. The resultant foam formed by combining the two should be between 600 and 800 c.c. Solution A, because of its acid reaction and consequent corrosive effect on iron, must be stored in a wooden tank or, if a steel tank be used, it must be lined with lead or some other acid-resisting material.

Such a system was recently installed by the Associated Pipe Line Co. at its Coalinga pump station, near the town of Coalinga, Fresno County, Calif. Some details are appended.

Solution Tanks of Coalinga Installation

This installation was designed to protect four 55,000-bbl. tanks each 114 ft. 6 in. diameter, one 37,000-bbl. tank 95 ft. 6 in. in diameter, one 30,000-bbl. tank 86 ft. in diameter and two fuel-oil tanks each about 8 ft. in diameter. Estimating 6 gal. of foam for 1 gal. of solution to produce over the surface of the various tanks a blanket of foam 5 in. in thickness in 5 min. would require that each solution be delivered at the rate of 550 gal. per min. for the 55,000-bbl. tanks, 368 gal. per min. for the 37,000-bbl. tank, 308 for the 30,000-bbl. tank and about 6 for the fuel-oil tanks. That is to say, to cover each tank once with 5 in. of foam would require about 6,200 gal. of each solution. In order to provide a reasonably large surplus of solution, in case it should become necessary to cover all the tanks with foam during a single conflagration, it was determined to use solution tanks 15 ft. 7/8 in. in diameter by 11 ft. 9 in. in height, having a capacity of 15,695 gal. each. These were made from No. 10 U. S. G. galvanized iron, all seams riveted and soldered. Each tank was provided with a 6-in. suction outlet placed on the side 3 in. from the bottom.

The tank for solution B, or the soda solution, was also provided with a 3-in. drain in the bottom. The one for solution A, or the acid solution, was lined with lead 1/8 in. thick weighing 8 lb. per sq.ft. In lieu of a drain for this tank a depression was made in the bottom (located immediately beneath the hatch) by riveting on a pan 1/2 in. deep by 12 in. in diameter. In case it should become necessary at any time to empty this tank, that portion of the liquid below the 6-in. pipe can be removed with a steam ejector or siphon, one end of which is placed in the depression. This was considered to be a cheaper and much more satisfactory method than using pipe for

FORMULA 1 (COMPONENTS ON A WEIGHT BASIS)

Solution A	Solution B
100 parts water	100 parts water
14 parts aluminum sulphate (crystal)	9¼ parts sodium bicarbonate
3 parts powdered extract of licorice	

FORMULA 2 (COMPONENTS ON A WEIGHT BASIS)

Solution A	Solution B
100 parts water	100 parts water
12 parts aluminum sulphate (crystal)	10 parts sodium bicarbonate
½ part acetic acid	1 part ground glue
1 part ground glue	¼ part glucose
¼ part glucose	

FORMULA 3 (COMPONENTS ON A WEIGHT BASIS)

Solution A	Solution B
100 parts water	100 parts water
10 parts aluminum sulphate (crystal)	1¼ parts ground glue
½ part sulphuric acid 66°B	¾ part glucose
	7½ parts sodium bicarbonate
	1/32 part arsenious oxide

*679 Sharon Building, San Francisco, Calif.

a drawoff, since the pipe would require to be made of lead or be lead-lined.

The tanks were placed on 4x12-in. redwood planking laid on mudsills on top of an earthen grade built up about 3 ft. above the pump foundation, in order that the solutions at all times might flow to the pumps under static head rather than through suction. The tops of the tanks were made of wood covered with roofing paper, the rafters being supported by the shell of the tank.

Since each solution tank is charged with that proportion of chemicals which will produce a maximum amount of foam on combination of equal parts of the solutions, it is very important that the pumps that are to deliver the solutions from their respective storage tanks to the mixing boxes at the oil tanks be designed to deliver as nearly as possible the same quantities in a stated time. Several types of pumps were considered. The duplex reciprocating type with a separate suction to each plunger (using one plunger for acid solution and the other for soda) was deemed undesirable not only because of the liability of one side of the pump short-stroking, but also because of the necessity of bringing such a pump slowly up to capacity when the time element might prove a most important factor. The first of these defects could be practically overcome by the use of a crank and flywheel pump. But the added first cost for such an installation, coupled with the loss of time in starting—which could not be overcome—seemed sufficient drawbacks to warrant the use of some other type.

The unit finally selected consisted of two 4-in. double-suction single-stage horizontal-shaft centrifugal pumps direct-connected to a 110-hp. impulse-type steam turbine.

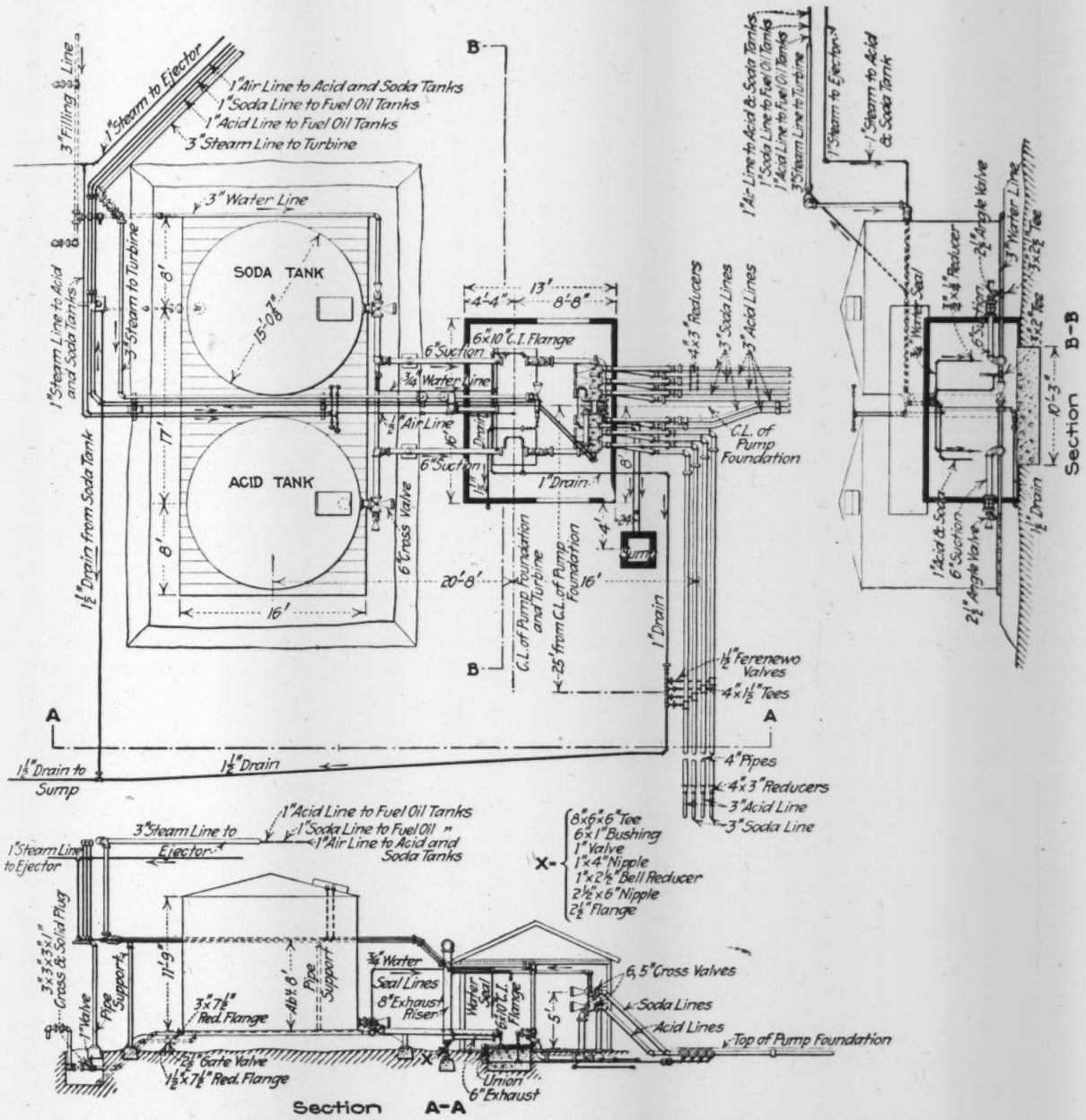


FIG. 1. GENERAL ARRANGEMENT OF FOAM SYSTEM AT COALINGA, CALIFORNIA

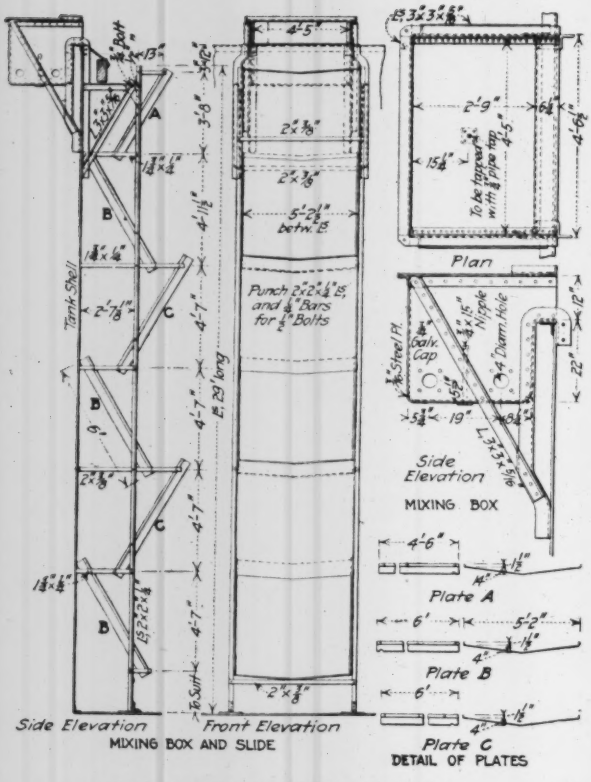


FIG. 2. FOAM-CHUTE DETAILS

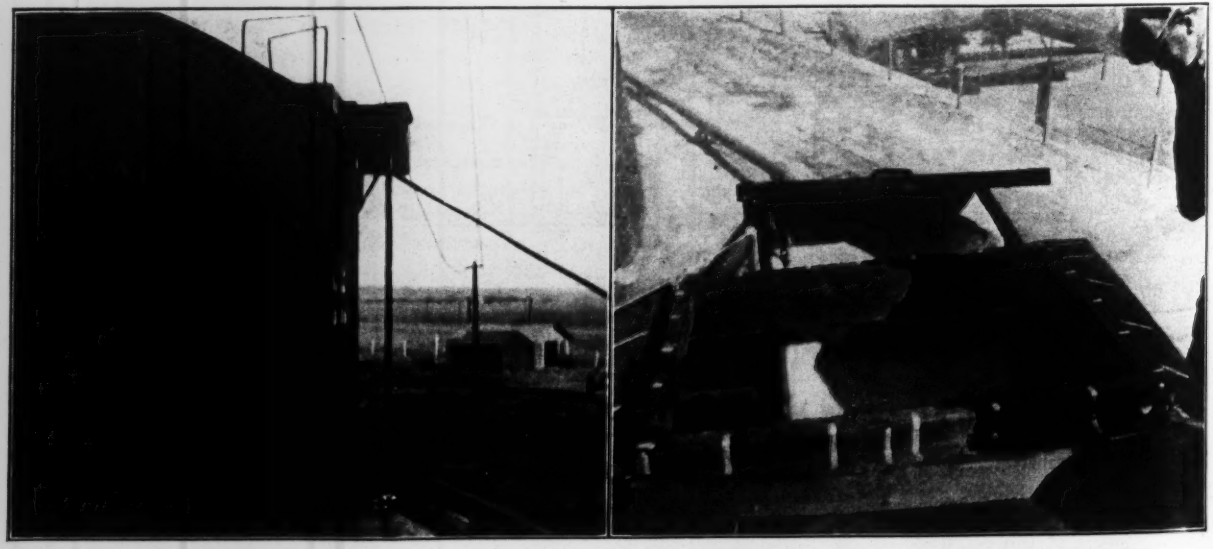
The whole was mounted on one bedplate. This unit was designed to deliver 550 gal. per min. against a head of 200 ft. with a steam pressure of 140 lb. per sq.in. The impeller and the wearing rings in the pumps used for solution "A" (the acid solution) were made from "acid bronze"; otherwise the working parts of both pumps were of cast iron.

An example of the positive action of such an installation is interesting: During a test of the system the foam was pouring into an oil tank, 470 ft. distant from the turbine house, in 1 min. 40 sec. (at the end of which time the pumps were working up to capacity) after the blowing of the whistle that announced the supposed fire.

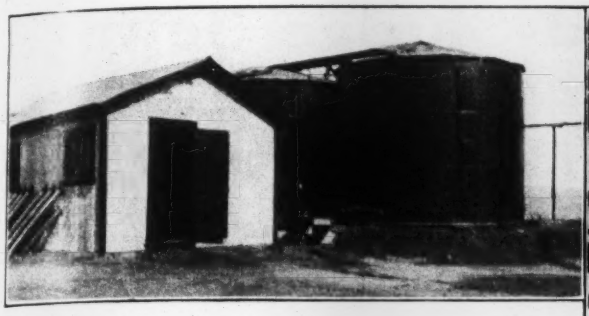
A separate system of piping, controlled from the turbine house, carries each solution to the respective tanks. This is arranged by allowing each pump to discharge into a manifold composed of 5-in. cross-valves placed end to end as shown in the illustration. The solution B manifold is immediately above solution A manifold, with the corresponding valves in each opposite each other. The stems of these valves are connected by sprocket chains so that the operator in opening an acid valve, which allows that solution to flow to a certain mixing box, is at the same time and at the same rate opening the valve admitting soda solution to the same mixing box. This then insures the proper proportion of delivery of the chemicals from the very outset of the pumping operation. Each valve is plainly marked with the number of the oil tank to which it supplies solution, and when the system is not in use all the valves are kept closed.

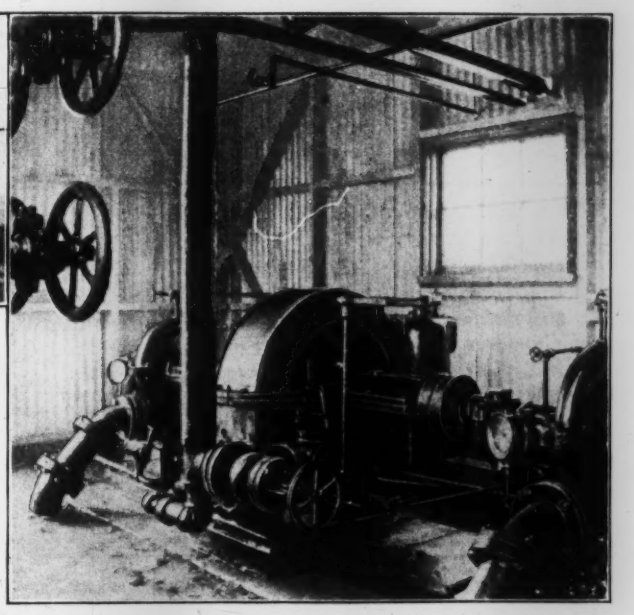
The pipe used was the ordinary mechantable galvanized-iron pipe from 1 to 4 in. in diameter, the size depending on the amount of liquid to be carried. The 1-in. pipe, which is taken off of the ends of the manifolds, serves the fuel-oil tanks. On account of the relatively high percentage of alkaline salts in the soil at this pumping station and their consequent corrosive effect on iron, all those portions of the lines that were buried in the ground before being laid were treated with a coat of refined asphaltum, then wrapped with asbestos roofing paper and again coated with asphaltum. All of the lines were carefully placed on true gradients, and drains were provided at the low points so that after any part of the system has been used the chemicals remaining in the lines may be drawn off and the pipes flushed with water.

The 6-in. suction nozzle from the solution A, or acid tank, was lead-lined up to the suction valve, about 8 in. from the tank. The valve itself had to be especially constructed. It was made by taking a Crane 6-in. flanged cross-valve and replacing the disk, seat, collar and valve sleeve with fittings made from an acid-resisting metal composed of about 5% antimony and 95% lead. The antimony was added not to increase the resistance to chemical action, but to make the metal more crystalline



FIGS. 3 AND 4. MIXING BOX ATTACHED TO 55,000-GAL. TANK; FOAM DISCHARGING INTO OIL TANK





FIGS. 5 AND 6. COALINGA SOLUTION TANKS AND TURBINE HOUSE; STEAM TURBINE AND CENTRIFUGAL PUMPS

and hence better adapted to withstand the wear and tear to which the working parts of such fittings are necessarily subjected. When the valve is closed, as is the case except when the system is in actual operation, all the parts that come in contact with the acid are thus composed of acid-resisting material. As a precaution against the valve leaking and allowing the acid to get into the suction piping, a ½-in. drain is provided in the bottom, which is kept open when the system is not in use. The water suction for flushing the lines is connected to one leg of this valve. The pipe lines discharge into mixing boxes. Each oil-storage tank is provided with one of these boxes supported by the shell of the tank and extending about 1 ft. above the top angle-iron, as shown in detail on the accompanying drawing. By having the box outside the tank it is believed that it and the pipes leading to it will escape serious damage from the usual gas explosion and, even though the roof of the tank collapses, will still be able to deliver foam upon the blazing surface.

Mixing Boxes and Foam Slides

The boxes were made from $\frac{3}{16}$-in. steel plate and are rectangular in shape. The ones for the 55,000-bbl. tanks are 4 ft. 5 in. by 2 ft. 9 in. by 2 ft. 10 in. deep, inside dimensions. They are provided with a lip 6¼ in. wide extending entirely across one side at a distance of 1 ft. 10 in. from the bottom. This lip rests on top of the tank shell and forms a weir over which the foam is delivered into the tank. The boxes for the 37,000- and 30,000-bbl. tanks are of similar construction but of smaller dimensions.

The solutions are brought into the bottom of the boxes through headers perforated on the under side with slotted holes. In this way they are given an opportunity to mix thoroughly before being discharged over the weir. The boxes for the fuel tanks consist merely of pans about 14 in. square and 10 in. deep, made of galvanized iron. They are supported at the centers of the tanks, beneath the roof, by the solution pipes themselves.

In case the tank that becomes ignited should contain only a few feet of oil, it is thought best that the foam, although the bubbles of which it is composed are surprisingly tough, should not be allowed to fall freely from the top of the tank to the surface of the oil, for the reason that many of the bubbles might be destroyed by the impact of the fall. To overcome such a possible defect a series of slides or baffle-plates were constructed from No. 10 U. S. G. black iron supported by 2x2x¼-in. angles, as shown on the drawing. The bubbles pouring from the mixing box fall upon the uppermost baffle-plate. Those which actually come in contact with the metal of the plate adhere to it to a marked degree and, because of their sticky nature, retard the whole mass. The result is that when the foam arrives at the bottom of the tank after having passed over a series of these baffles, its velocity is not very much greater than when leaving the mixing box.

In preparing the chemical compounds for the Coalinga plant each solution tank was filled with fresh water to within about 2½ ft. of the top (formula No. 3 was used). For solution A, or the acid solution, the water was then heated with open steam to a temperature of 180° F. and the aluminum sulphate and sulphuric acid added. During the addition of the chemicals a thorough agitation was kept up with compressed air. For the soda solution, the ground glue was first added slowly to the water before heat was applied and the mixture was thoroughly agitated. It was then raised to a temperature of 160° F. and the glucose and bicarbonate of soda put in and agitated until all three were completely dissolved. Lastly, the arsenious oxide was put in. Both tanks were then filled to the top with water, and agitation was continued until no undissolved chemical could be detected on the bottom of the tanks by stirring with a long pole. The solutions were then allowed to stand for 24 hr., after which time they were again tested with the pole and showed an apparently uniform mix in each tank. It has been suggested that a much better way to test for a homogeneous mix would be to "thieve" the tank at various depths and compare the samples so taken as to gravity, and in future this method probably will be followed.

Since the glue will slowly decompose, more must be added from time to time. Each solution will therefore be tested, as previously outlined, at least once a month, and whatever additional components are required to bring it up to specifications will be supplied.

When the system has been used for fire or test, the acid remaining in the acid pipe lines is first drawn off. Then these pipes are filled with the soda solution, which is allowed to stand several minutes, or long enough to neutralize all the acid, before being drawn off. The system is then thoroughly washed with water.

Status of Activated-Sludge Sewage Treatment

By George T. Hammond*

SYNOPSIS—After visits to five working-scale plants the author, who has been in engineering charge of activated-sludge experiments at Brooklyn, draws some noteworthy conclusions regarding the probable desirability of preliminary screening, the apparent advantages of pipe-grid as against porous-plate or porous disk diffusers, the uncertainty, but great importance, of sludge recovery for fertilizer base and of sludge dewatering. He considers the activated-sludge process, while promising, as still in the early experimental stage, but fortunately the experiments are on a large scale and in charge of able men.

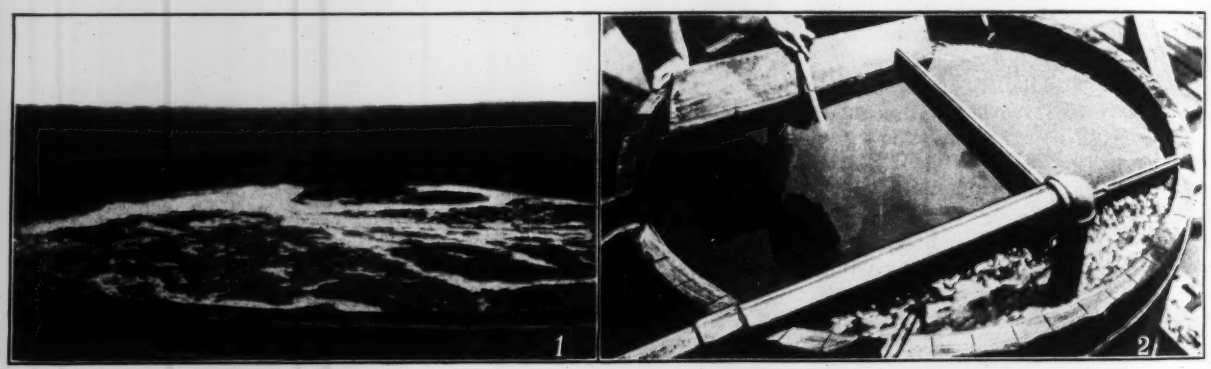
Sewage treatment by aëration in the presence of activated sludge has now been under extensive observation and experiment in this country in plants provided on a working, rather than a mere laboratory, scale for about one year, the earliest having been started in March, 1915. Considerable work has been done on this method in Brooklyn, and much that has been accomplished there has already been published. A careful analysis of results led to the desire for comparison with the achievements of others in this field, and visits were planned to each of the larger plants engaged in this study.

Within the last few weeks the writer has visted Baltimore, Milwaukee, Chicago and Cleveland, and the observations and conclusions expressed in the present article are the result of these visits and of the experience gained from the Brooklyn plant. Two plants were studied at Chicago—that of Armour & Co. and that conducted by the Sanitary District of Chicago. The data presented are derived from the six plants.

The first conclusion reached is that the principle offers a method by which clarification of sewage may be secured with reliability, though at a rather questionable cost, and that further experimental work to clear up doubtful points may in many places render its employment attractive, but that the expense of obtaining a high degree of stability will be relatively high. One of the principal advantages offered is the clear and sparkling effluent that may be secured, and of much importance also is the absence of all smell from the aërating tanks.

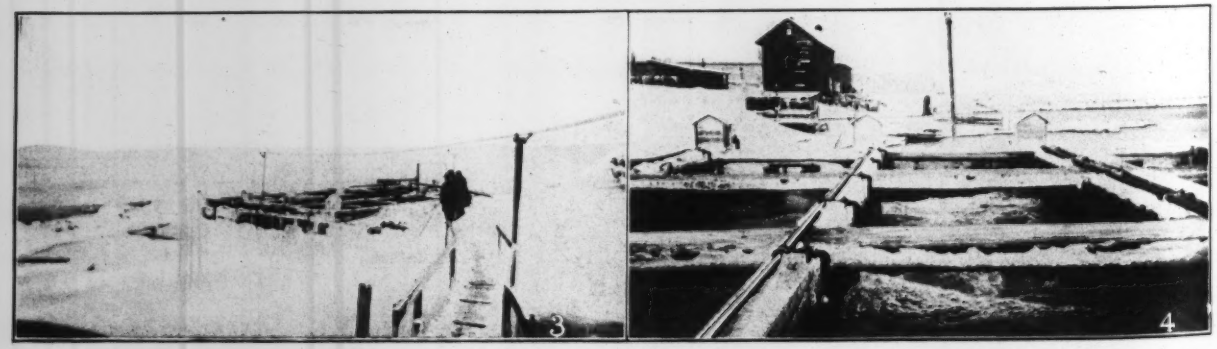
The second conclusion is that the method is not without many difficulties, some of which, unless overcome, are

*Engineer of Design and in Charge of the Sewage Experimental Plant, Bureau of Sewers, Brooklyn, N. Y.



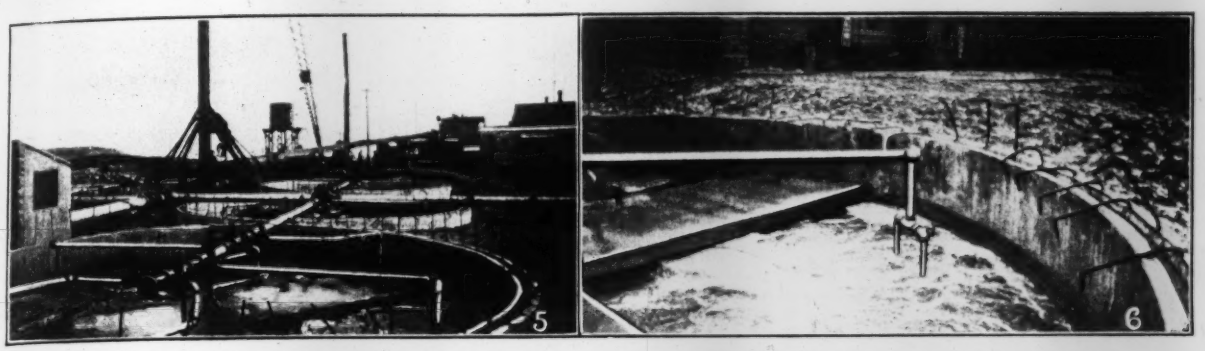
FIGS. 1 AND 2. TWO ACTIVATED-SLUDGE TANKS IN OPERATION IN BROOKLYN BOROUGH, NEW YORK CITY, AUGUST, 1915

Fig. 1—Tank aërator, with air supplied through grid of perforated pipe located 22 ft. below surface of sewage. Compare this surface with surfaces of tanks aërated through porous disks and plates. Fig. 2—Small continuous-flow tank of Imhoff type. The clearness of the settled sewage is indicated by the rule thrust into the treated sewage, the rule being visible to its end. The ebullition in the foreground is in the gas vent, outside the settling chamber



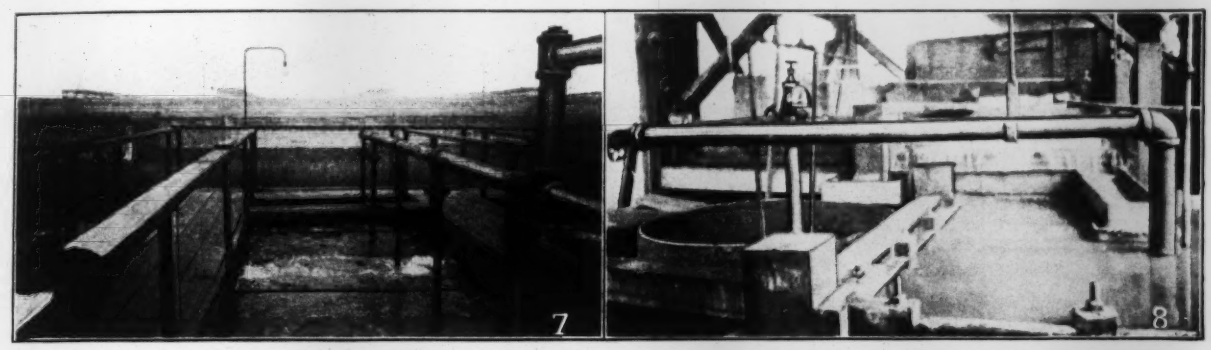
FIGS. 3 AND 4. WINTER VIEWS OF LARGE ACTIVATED-SLUDGE TANKS AT CLEVELAND, OHIO, TAKEN MAR. 22, 1916

Fig. 3—General view of plant, with Lake Erie in background, frozen. Operation of tank not interrupted by cold weather. Fig. 4—Surface of aërating tank. Air supplied through porous plates set in valleys at bottom of tanks



FIGS. 5 AND 6. GENERAL AND NEAR VIEWS OF LARGE NEW ACTIVATED-SLUDGE TANKS, MILWAUKEE, WIS., MAR. 20, 1916

Fig. 5—General view. Air supplied through porous plate. Observe wave on surface in middle foreground. Fig. 6—Near view. Note irregular ebullition as compared with surface of Brooklyn tank (Fig. 1), supplied through grid. The Milwaukee distribution is one of the best observed for the plate diffusers



FIGS. 7 AND 8. TWO INDEPENDENT ACTIVATED-SLUDGE INSTALLATIONS AT CHICAGO, MAR. 21, 1916

Fig. 7—Sanitary district of Chicago. Air supplied through porous plates. One of the best air-distribution results observed. Fig. 8—Armour & Co. plant. Settling tank in foreground; overflow weir behind that

of such importance as to make its employment of questionable advisability. There are some difficulties about the design of the plant which, although troublesome at present, may be met and solved by the ingenious designer, such, for instance, as the best method of air distribution, the size and arrangement of tanks, etc.

Concerning the design of such a plant but little is settled, upon which one can decide his own problem. Every existing plant has its own general design and its personal peculiarities. All agree in being different from the others in essential features; all agree also in giving very different results.

The thing that is giving the greatest trouble is the sludge problem. The production of a highly putrescible sludge in quantities from 15 to 30 cu.yd. per 1,000,000 gal. per day is not to be considered lightly. In a plant provided to treat 10,000,000 gal. there will be 150 to 300 cu.yd. to be disposed of daily. The sludge is very moist, the water content being 97% at Cleveland and 98% at Milwaukee. The sludge possesses a certain value for use as a fertilizer base, but this will vary with the length of aëration and the character of the sewage. In order to be salable it must be dried to a moisture content of 10%, and to accomplish this, without causing a nuisance, at a practicable cost not exceeding the value and fair charge for disposal of the sludge offers a difficulty not yet overcome.

The value of the dried material as fertilizer base is stated to vary from $5 to $20 per ton; but the amount actually secured from drying and selling depends upon many conditions, such as the possibility of storing the dry sludge, transportation facilities, commercial demand, etc., and cannot be predicated on the mere valuable constituents of the dry sludge.

It may be pointed out in this connection that vast quantities of municipal wastes, containing large fertilizer values, are now being unwisely neglected. Only six cities in the United States operate their own garbage-reduction plants, and only 20 more send their garbage to privately owned plants, out of the 199 cities having a population of 30,000 and over; and these produce in the course of a year 160,000 tons of fertilizer out of 1,045,000 tons of garbage. It is estimated by the United States Department of Agriculture that at least eight times more fertilizer might be made from wasted garbage alone, which has to be disposed of and could readily be used for the purpose. The recovery of value from this material is greater than we can ever expect from average dried sewage sludge; and while the garbage is neglected, notwithstanding the profit of working it, what can we expect will be the attitude of the public toward providing expensive fertilizer-recovery plants in connection with sewage disposal?

This is a commercial and practical question, the failure to solve which may render the use of the activated-sludge method impracticable in many places. A more hopeful view may be gained, however, by consideration of methods of reducing the volume of the sludge-making materials by some form of preliminary treatment previous to aëration. The possibility of this is suggested by examination of all the plants studied.

A certain proportion of the suspended solids, possibly as high as 25% to 40%, can readily be removed from the sewage by means of medium-fine screening. The writer

feels certain that it is cheaper in almost every form of sewage-disposal treatment to screen out as much as practicable. It costs less to dry and burn or otherwise dispose of screenings than it does to permit them to remain and increase the expense of sewage treatment and add to the volume of sludge.

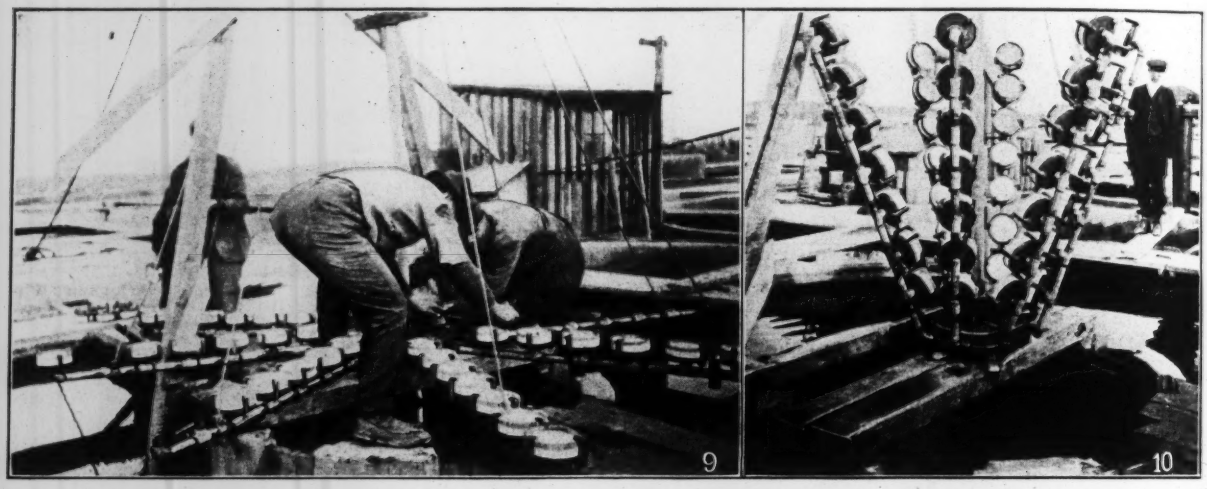
As a preliminary to activation the screen should not be too fine. An aperture less than ½ in. would probably remove material that should be activated, while larger than $\frac{3}{16}$ in. would admit substances that should be treated as screenings.

In Brooklyn we are preparing an experimental unit for activated sludge, to continue the work of last year on a much larger scale, and shall treat only sewage that has passed through our new Riensch-Wurl screens. The solids that the screens will remove are shreds of string, pieces of fabric, leather, cotton waste, paper, hairs, bones, bits of wood, corks, orange peel, skins and pieces of vegetables, tea leaves, etc., as well as undisintegrated fecal masses, to attempt the treatment of which by an aëration

to meet. At Milwaukee several forms of press have been tried. In Cleveland it has been found that screenings from a Riensch-Wurl screen can be readily dried to 30% moisture in a centrifugal drier. The drier employed to take care of screenings from 6,000,000 gal. has a basket only 20 in. in diameter and 10 in. in depth and yet has sufficient capacity to more than do the work. This is to be tried on activated sludge; but unless press drying is resorted to as a preliminary, its success is doubtful. In any case further drying will be necessary to obtain a content of 10% moisture.

It would seem possible to use a press in which canvas bags of proper size to fit the basket of a centrifugal drier are placed in such a way that the sludge, having previously been concentrated by standing in a deep tank, could be allowed to strain through the bags until filled with retained material, the bags after pressure being removed to the centrifugal to complete dewatering.

The Schaefer-ter-Meer drier may prove of service for activated-sludge drying, but it would have to be followed



FIGS. 9 AND 10. AIR-DIFFUSER DISKS FOR ACTIVATED-SLUDGE TANK, BALTIMORE, MD., JAN. 26, 1916
Fig. 9—Putting disks in frame. Fig. 10—Frame and disks closed like umbrella frame, ready to be lowered to bottom of tank, where frame was opened to assume a horizontal position

period of 4 hr. would be useless as well as unfair to the activated-sludge method. In visiting the plants previously mentioned the need of screening the entering sewage was very apparent in every one, as well as in the Brooklyn plant.

Methods of sludge disposal, without going to the expense of drying and recovering the fertilizer value, should be given an extended trial. Our experience in Brooklyn suggests that it would be practicable to digest the sludge, without nuisance, in properly designed separate digestion tanks, the entire process of handling being without exposure to the air. The sludge could be thus rendered as inoffensive as Imhoff sludge and would dry as readily.

The Dixon method of sludge treatment may also be tried, but this is more in the line of fertilizer production. It is now being experimented with in Brooklyn, a demonstration plant having been installed by its promoters.

Dewatering the sludge is a matter of much difficulty and expense. So far no really satisfactory method has been found. One difficulty is the requirement that no more than 10% moisture shall remain in the dry material in order that it may be marketable as a fertilizer base. This is a very hard condition for a sewage-disposal plant

by further drying. Tests made with it at our Jamaica plant show that, operating on sludge containing 91.5% moisture, the dry material had a moisture content of 64.2%. The figures are averages of performance. It must be admitted that the sludge problem has not been solved and is our greatest difficulty.

It was anticipated that difficulty might be experienced from the effect of cold weather on the activated-sludge process. Operation of the plants during the past winter has proved this fear groundless. The specific heat of air is such that but little heat is removed from the sewage. The plant in Cleveland, started the latter part of January, was able to collect sufficient activated sludge for continuous operation in ten days. The loss of heat in the sewage through the plant is only 1° C. The plant is in a very exposed situation on the lake front and, as seen by the writer, was in the midst of ice and snow, with a temperature below freezing. It was apparently unaffected by the cold.

Air-distribution troubles have been pretty general. Wherever porous disks or plates of porous material have been the means of application there has been trouble. In Brooklyn, porous disks were used in one tank, and a

pipe grid was used in another. The result was all in favor of the pipe grid, which after supplying air for aërating a deep sewage tank for 2½ yr. is still in good order and scarcely needs cleaning. The distribution of air, as seen on the surface of the tank contents, is more even and less marked with local ebullition in this tank than in any tank, seen by the writer, in which porous plates are used. The grid should be so designed that it can be drained through an outlet pipe and should have a connection with the city water-supply, if possible, so that it can be flushed out at times. A steam connection, so that steam can be turned on to drive out grease when the tank is empty, would be a good feature and will be tried in Brooklyn. The pipe grid should be so designed that there will be no dead ends. A grid should have a surrounding pipe connecting the outer ends of the cross-pipes, and preferably the air should be supplied through a cross-pipe placed at right angles to the grid pipes. The bottom of the tank should be designed with shallow valleys with sharp slopes, in the lowest part of which the grid pipes are placed, so that no sludge can settle below the air apertures.

It is true that in laboratory work a higher efficiency may be gained for the air by securing very fine bubbles, and there may be a "critical size"; but one must provide such a design that under working conditions, always subject to unforeseen disturbance, the best average effect can be secured. In a working plant the difference in effect between "critical sizes" and the ordinary bubble does not give advantage enough to overweigh the danger of the clogging of very fine porous air distributors. For practical use over a long period the writer believes that the perforated-pipe grid is as good as the porous plate and will give the plant a better average effluent. With the grid the air supply is subject to very small variation in quantity, while with the porous plate great variation is possible from clogging, which even results from microscopic dust carried by the air.

It is possibly for this reason as much as from any other of the reasons assigned that the writer observed that all the plants seen in operation were doing far less than their nominal capacity. The Milwaukee plant, visited Mar. 20 of this year, was said to be treating only 750,000 gal. per day. Its nominal capacity, with 4-hr. aëration period, is more than double this amount. The Cleveland plant, visited Mar. 22, has a nominal capacity, with 4-hr. aëration, of 1,000,000 gal. per day; it was treating only 400,000 gal. per day. The same conditions were found at Chicago, visited Mar. 21. In consequence of air-distribution troubles the Baltimore plant was not working when visited, and a new arrangement of porous disks was being installed.

The volume of air used per volume of sewage in all these plants varied widely, though all were attempting only to obtain an effluent of low stability. Of course, special conditions at the stockyards in Chicago would except them from this comparison. But the sewages of Brooklyn, Cleveland and Milwaukee, on the average, do not differ very widely in character.

In conclusion it must be admitted that the activated-sludge process is not as yet out of the early experimental stage, that as yet none of the problems surrounding it are even fully understood, and all are awaiting further study. No forecast as to its value for sewage treatment on a large scale seems to the writer to be now justified.

Duty Record for Turbine-Driven Centrifugal Pumps

A new high record for the duty of a steam-turbine-driven centrifugal water-works pump has been made at Montreal; a figure of 168.3 million foot-pounds per 1,000 lb. steam (at 140 lb. gage and 100° F. superheat, excluding friction head loss through condenser and piping) was obtained in tests of a geared unit having a daily capacity of 30 million Imperial gallons per 24 hr. against 210-ft. head. The unit was made by the De Laval Steam Turbine Co., Trenton, N. J., and was installed in the low-level station of the City of Montreal. The appended data showing results of tests have been furnished by the manufacturers.

In this station are eight pumps of various types having a total daily capacity of 108 million gallons. The older units are reciprocating machines, but later centrifugals driven by triple-expansion engines were added. The specifications for the new pumps were drawn up by T. W. Lesage, Engineer and Superintendent of water-works, and included the following items:

Brake horsepower of turbine	1,600
Number of stages	14
Speed of turbine, r.p.m.	3,600
Ratio of gear	6 to 1
Diameter, suction and discharge, in.	30
Speed of pump, r.p.m.	600
Pressure head, lb. per sq.in.	85
Suction lift, ft.	5—8
Efficiency of pump	80%
Weight, pump, turbine and gear, lb.	80,000
Floor space, sq.ft.	247
Weight, condenser and auxiliaries, lb.	43,300
Floor space, condenser, sq.ft.	100
Area, condenser, sq.ft.	3,000

The duty was required to cover all losses, including pipe friction, velocity head and steam for auxiliaries (credit allowed for heat returned by feed-water heaters). It was further stipulated that in determining the duty the pumping unit should be credited with the vertical distance from the water in the suction well to the center of the pump shaft, while the discharge pressure, would be measured at the point of connection with the city main, corrected to the elevation of the center of the pump shaft, the pumping unit thus being charged with the friction through the piping, condenser shell, check and gate valves, etc.

It was required that the unit should be tested to its full capacity at the builder's shops before shipment and after installation at Montreal should be run continuously for 15 days of 24 hr. each without shutting down, at the conclusion of which endurance test a duty test of 8 hr. continuous running was to be made. In event of failure to develop the duty guaranteed a deduction of $2,000 was to be made for each million foot-pounds by which the duty should fall short of the stipulated guarantee.

The following figures summarize the results of the final duty test, which was carried out on Oct. 15, 1915:

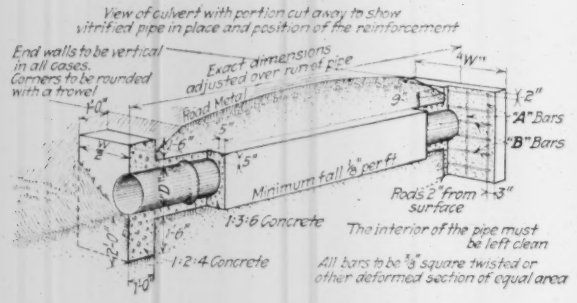
Average water delivered, Imp. gal. per hr.	1,308,808
Corresponding rate per 24 hr.	31,411,292
Average pressure at gage on discharge pipe, ft.	197.274
Average suction lift from water level to center line of pump, ft.	8.6
Total average corrected head, ft.	205.874
Average water horsepower	1,360.85
Steam consumption, corrected for credits, lb. per hr.	17,344
Average absolute steam pressure, lb. per sq.in.	159.7
Average superheat at turbine, deg. F.	63
Steam consumption, corrected to contract conditions, lb. per hr.	16,638
Steam per water horsepower, actual, lb.	12.7
Duty per 1,000 lb. of steam supplied, actual, in million foot-pounds	155.356
Duty, corrected to specified superheat and pressure	162.0
Duty, corrected to superheat and pressure and for condenser and piping friction	168.3

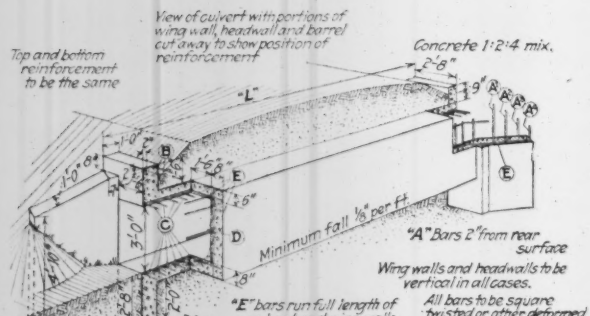
Field and Office

Perspective Working Drawings in Ohio Highway Standards

Perspective representation is used effectively on many of the standard-design sheets of the Ohio Highway Department. The simpler types of structure lend themselves best to this form of representation; no attempt has been made to apply it to complex structures like plate-girder bridges.

Two of these perspective drawings are reproduced herewith, to show the clearness and saving of space which the method secures. It will be understood that below the


View of culvert with portion cut away to show vitrified pipe in place and position of the reinforcement
End walls to be vertical in all cases. Corners to be rounded with a trowel
Exact dimensions adjusted over run of pipe
Road Metal
"A" Bars
"B" Bars
Minimum fall ⅛" per ft.
Rods 2" from surface
1:3:6 Concrete
The interior of the pipe must be left clean
1:2:4 Concrete
All bars to be ⅝" square twisted or other deformed section of equal area


View of culvert with portions of wing wall, headwall and barrel cut away to show position of reinforcement
Top and bottom reinforcement to be the same
Concrete 1:2:4 mix.
"L"
Minimum fall ⅛" per ft.
"A" Bars 2" from rear surface
Wing walls and headwalls to be vertical in all cases.
"E" bars run full length of culvert and wing walls.
All bars to be square twisted or other deformed section of equal area
"C" & "D" bars 1" from surface
Center line of culvert
Outline base of headwall

TWO PERSPECTIVE WORKING DRAWINGS USED IN OHIO HIGHWAY DEPARTMENT STANDARDS

Standard tile culvert shown above and standard 3x3-ft. box culvert shown below

sketch, on each sheet, are given notes of instruction and tables of sizes of reinforcement, etc. Thus the sheet is a complete working drawing for a structure called for at a particular location on a road job, except as modified by sketch in the plans for the road. The depth of foundation of headwall (in the standard sheet for the tile culvert shown 2 ft. below invert) is frequently increased to suit the local ground, or in place of the plain headwall a box inlet for the side ditch is shown. In such cases the special sketch sheet gives in simple outline the barrel and headwalls of the culvert, states its length and grade, notes the quantities of materials and shows in detail the part that is to be different from the standard; it further bears the note "Standard Design," to indicate that parts not fully shown are to be built according to the standard sheet for the type of structure in question.

This perspective representation has generally proved satisfactory to the contractors. In one or two instances there has been complaint that it is not as easy to understand as an ordinary working drawing made on rectangular projection. The reader can easily judge for himself how far this complaint is justified.

Tests of Concrete Distributed by Short Chute

Tests to study the question whether spouted concrete is injuriously affected by the process of spouting were made recently by a committee composed of the following: Ernest McCullough, consulting engineer, Chicago; John Wilson, consulting engineer, Duluth, Minn.; G. E. Scott, contracting engineer, Norwalk, Ohio; Ernest Ashton, chemical engineer of Lehigh Portland Cement Co., Allentown, Penn.; A. D. Williams, chief engineer, West Virginia State Road Bureau, Morgantown. The committee acted for the National Conference on Concrete Road Building.

Over 120 samples of concrete were taken, in 6x12-in. test cylinders, from 1:2:3 concrete mixed to various consistencies (stiff to sloppy) and chuted through a 12-ft. chute on a paving mixer, the chute being set at various angles (15° to 25°). The time of mixing was varied from ½ min. to 2 min. The test results (printed in Report of Committee VIII, which may be obtained from J. P. Beck, 208 South LaSalle St. Chicago), show that most of the samples were of very high strength, the crushing strength being 3,500 to 4,000 lb. per sq.in. at 1 mo. age and 5,000 lb. at 2 mo. Hand-mixed specimens, also 1:2:3, gave only 2,950 lb. at 1 mo. and 3,800 lb. at 2 mo. (average of five specimens from separate batches, all figures being close together). Thus the machine-mixed and spouted concrete was much stronger than hand-mixed and hand-placed concrete.

With the machine, times of mixing as low as ½ min. gave lower results. Sloppy consistency generally produced low strength. With a consistency pronounced ideal for general concrete work, the ½-, ¾- and 1½-min. mixtures were recorded as "too stiff to flow in chute," and the 2-min. mixture "had to be pushed down the chute," when the chute was at 20° angle. In one test made with 15° angle the mixture used was much softer and gave 500 lb. lower strength.

Prof. D. A. Abrams, of Lewis Institute, Chicago, tested the specimens. The committee reached the following conclusions: Distributing concrete from the mixer by chute is good, when the method is used properly. The pitch of the chute should be steep enough to deliver concrete of a proper consistency readily; the least angle should be about 20° and the maximum amount of water should be 6 lb. per cu.ft. of loose materials. There is no reason for favoring boom-and-bucket distribution over

chute distribution. When buckets are used, the preferable type is one that dumps by overturning.

With regard to mixing, the committee reported its belief that for roadwork the speed of the mixer drum should not exceed 16 r.p.m., and each batch should have not less than 10 revolutions and not less than 1 min. of mixing. The last recommendation is based not on the strengths found in the tests, but on the observation that when mixing less than 1 min. there was a marked difference between the first and the last concrete of the batch.

Waterproofing Membrane Intact After Extreme Expansion

A notable instance of a waterproofing membrane that remained intact while the masonry beneath cracked and separated is seen in a retaining wall on the Bay Ridge Improvement of the Long Island R.R. at Myrtle Ave. station in Brooklyn, N. Y.

A stairway was built down through a wall, as shown in Fig. 2, an expansion joint being left across the whole cross-section near the edge of a mid-height landing. This work was done in 1912, and the bituminous membrane cap was put on, as seen in Figs. 1 and 2, in January, 1913. The waterproofing was done by the Masonry Waterproofing Co., Brooklyn. By April, 1913, the expansion joint had opened up about ⅞ in., though no leakage was detected. At that time the membrane was examined and found stretched tight as a drumhead over the crack. A strip 7 in. wide and 15 in. long was cut out and peeled down, as shown in Fig. 1. The bituminous compound had adhered to the concrete so that a putty knife had to be used to chop the fabric strip away.

This membrane was made up of cotton-drill sheets 2 ft. square, saturated in a compound blended to secure maximum cohesion and adhesion and laid with 2-in. laps all around. Careful inspection showed that the opening of the expansion joint had been accommodated by slipping of the sheets at the laps—the maximum movement being about ⅛ in. nearest the joint and some slip being appreciable for four sheets back on each side of the joint. After inspection the strip was put back and a new sheet sealed over the spot. The joint was filled with 1:2½ portland-cement grout poured in behind dams after the joint had been raked out as much as possible from the stairways. In October, 1913, the joint was observed to have opened ¼ in. more, but the wall was still dry. It was then regrouted. In November, 1915, there was another opening of ¼ in., but the joint was still dry.

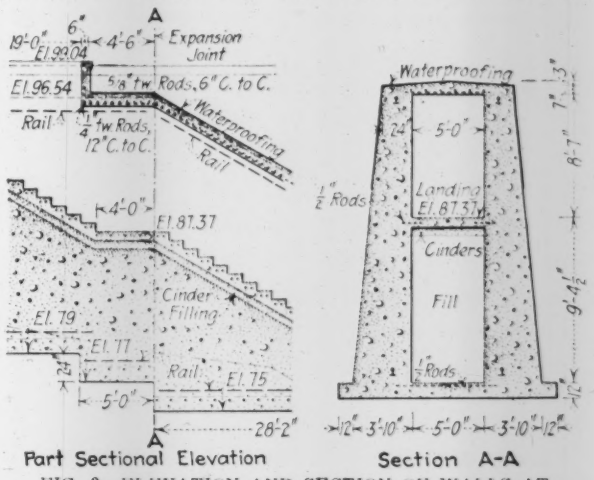


FIG. 2. ELEVATION AND SECTION OF WALLS AT STAIRWAY, MYRTLE AVE. STATION

Lubricated Trunnion Pin for Bascule Bridge

By Charles P. Wiweke*

The main trunnions of a bascule bridge are usually so located that they get scant attention beyond, perhaps, what is given during the yearly overhauling of the structure. Yet it is very important that they be kept lubricated.

*104 Willett St., Albany, N. Y.

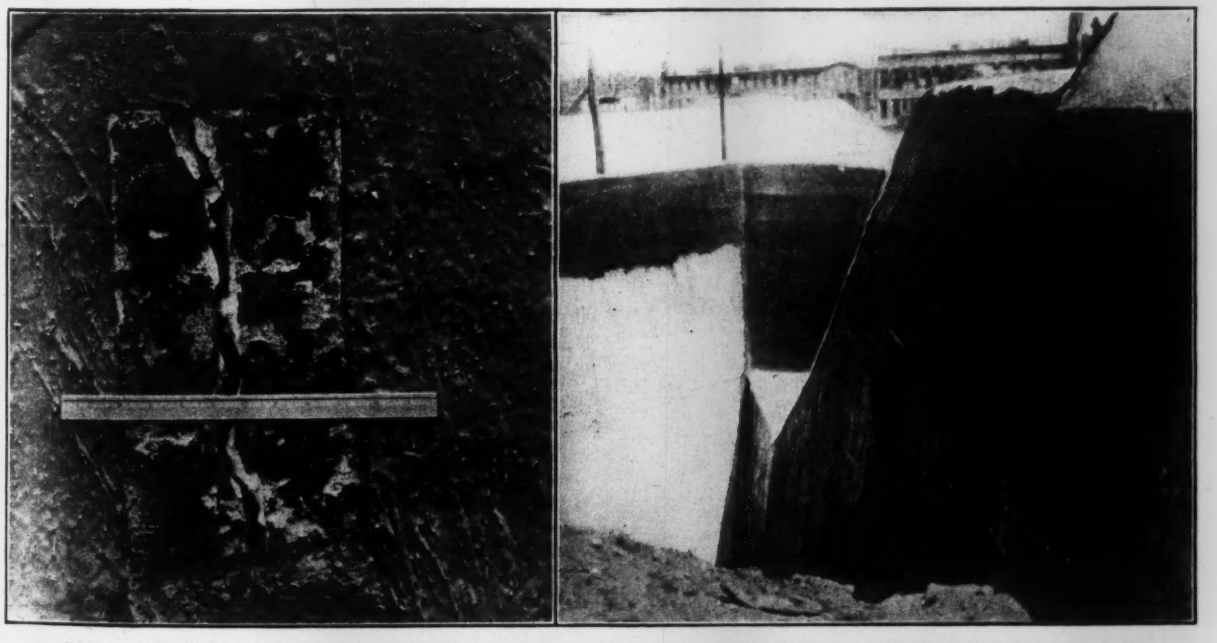
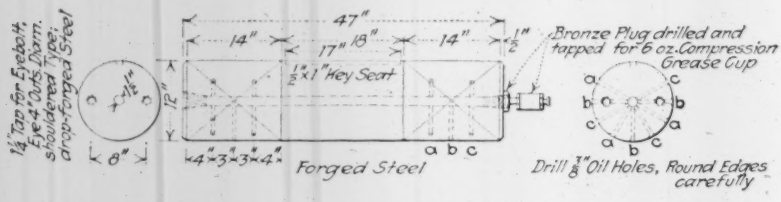


FIG. 1. WATERPROOFING SUBJECTED TO EXPANSION; BAY RIDGE IMPROVEMENT, LONG ISLAND R.R.

The sketch shows a pin with a central hole used as an oil reservoir. The hole is called for in all large pins, in order to make sure of getting a sound pin. The hole being there in any event, plugging the ends and drilling the radial holes convert it into an oil reservoir that will lubricate the bearing all around.



TRUNNION PIN WITH OIL RESERVOIR FOR A BASCULE BRIDGE

The eye-bolts are for ease in handling the pin. It is also worth notice that experience has shown the necessity of securing the pin against endwise motion. The tendency is there, and the pin will creep unless prevented. Ordinarily, several 1-in. setscrews are used.

Practice in Rapid Taping in Montana Mountain Work

By E. E. Thum*

The note from W. H. Rayner in *Engineering News* of Mar. 30, 1916, p. 614, regarding sag and slope diagrams for the steel tape, prompts an expression of methods found very useful for rapid and accurate mineral and legal survey work in the mountains of Montana.

Eliminate the sag correction entirely by making it equal and opposite to the correction for stretch. Formulas for this operation are given in many texts on surveying; it is only necessary to know the modulus of elasticity of the tape and its weight per unit length, when a short table can be quickly computed giving the proper pull for measurements with unsupported lengths varying by 25 ft. This table is recorded in the chainmen's notebooks, but is unconsciously memorized with a day's use.

In rough country a 300-ft. tape is essential. In order that the maximum tension in such a tape be kept under 30 lb., a light narrow band is required. Larger tensions are out of the question for cramped quarters or icy slopes.

In order that the pull may be measured, both head and rear chainmen are provided with spring balances. To grasp the tape at any point in its length, easily, quickly and without injuring the tape by sharp bends, they also carry a small lineman's comealong—a small brass clamp open at the side and built with an eccentric joint that grips tighter the harder you pull.

Measure to nails in all cases. On long shots set line hubs at 300-ft. intervals or on commanding points. In rough or timbered country the instrument points will usually be less than 600 ft. apart, when all measurements can be made to the instrument. On smooth ground measure along the ground (no sag) with the standard pull. On rough ground measure unsupported to the instrument axis. Swing free across large gullies.

Slopes should be taken on all measurements. This can be done with the vertical circle of the transit, sighting to the line hub or to the approximate height of instrument on the chainman's body, in case the measurement is taken to the axis of the transit or to the hub, respectively. A good Abney level in the hands of the head chainman will serve excellently for intermediate shots. Lacking this, set up quickly near every other line hub and measure the vertical angle with the transit both to the rear and ahead.

Correct the inclined measurements to horizontal by multiplying them by the versine of the vertical angle measured. The result is the amount the observed distance exceeds the true horizontal. In case a table of natural versines is not available, subtract the natural cosine of the slope angle from unity. These corrections can usually be figured on a slide rule.

Temperature corrections are liable to be large and hard to compute, using ordinary tapes. Thermometers are rather fragile equipment at best and are continually being broken. Again it is very questionable whether the temperature observed is even a fair indication of the temperature of the tape, especially under conditions such as the following: Sparsely wooded country, soft snow on the ground, bright sun, and air temperature about zero on the shady side, 40 or 50 in the sun. The only practicable way out of such a dilemma is the use of a tape made of "invar," a high-nickel steel whose coefficient of expansion at atmospheric temperatures is so small that it may be disregarded except in the most precise base-line work.

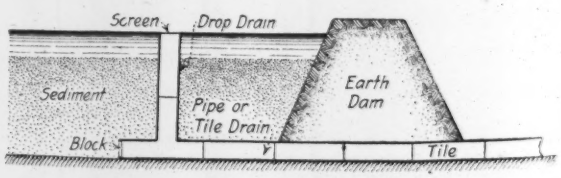
All horizontal angles should be repeated, the true angle regarded as one-half the double-angle measurement. In case the slopes are steep, plunge the instrument and double the outside angle, recording one-half the double angle thus measured as well. By properly averaging the results of the direct and reverse operations, any error in instrumental adjustment is largely eliminated.

Using the foregoing methods, one will be able to make most excellent closures over the worst kind of country at a surprising rate of speed. With practice a party will become quite confident of its work and will run out spurs with every probability of the resulting data being of a high order of merit.

*Assistant Professor of Metallurgy, University of Cincinnati, Cincinnati, Ohio; formerly Civil and Construction Engineer, Anaconda Copper Mining Co.

Sediment for Filling Gullies in Flood-Scoured Ground

In reclaiming and improving lands subject to damage by erosion due to floods one problem is the filling of the gullies in the surface. A method that has been used in Missouri and North Carolina is shown in the accompanying drawing. A bank or dam of earth is placed across the gully, with a line of drain tile or sewer pipe laid beneath it. On the upstream side of the dam this drain



METHOD OF FILLING GULLIES IN ERODED LAND

has a vertical extension. Water flowing down the gully forms a pool in which the sediment due to erosion is deposited, while the comparatively clear water flows away through the drain, as is shown in the accompanying drawing, which is taken from a bulletin (No. 236, February, 1916) issued by the North Carolina Experiment Station at Raleigh, N. C.

There will be a series of dams and drains in the gully; and as the deposit fills in, the dams are raised and the drop drains increased in height. This method does not provide against the erosion of the land by the surface water that finally reaches the gullies, and for this reason the terracing of the surface is recommended in combination with the use of the dams and the drains.

Light Steam Shovel with Scraper Action

The "Keystone" traction excavator is a successful departure in steam-shovel manufacture. It is especially applicable to road grading, and a scoop of special design and action is provided for this service. It can also be adjusted for trenching, through-cutting and side-hill excavation by rearranging interchangeable sheaves and tackle and changing to the proper form of shovel or scoop.

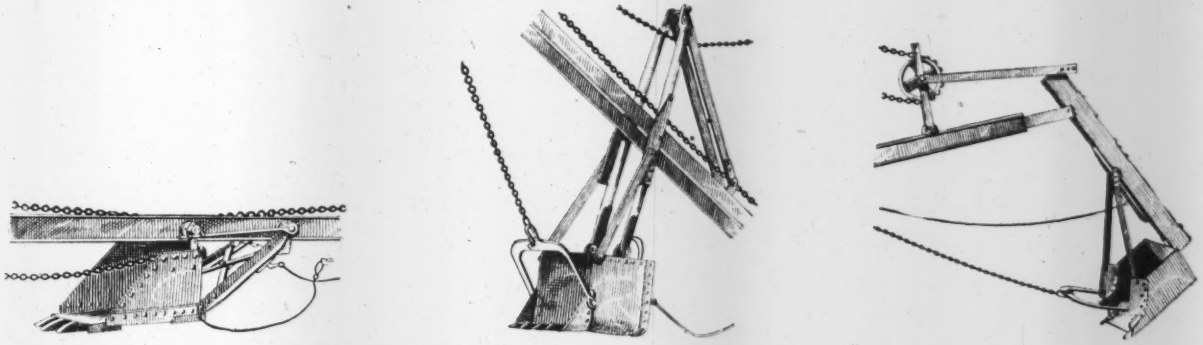


FIG. 1. THE THREE SCOOPS—THE SKIMMER FOR ROAD GRADING, DIPPER FOR REGULAR STEAM-SHOVEL WORK, DITCHER FOR TRENCHING, AS THEY ATTACH TO THE BOOM

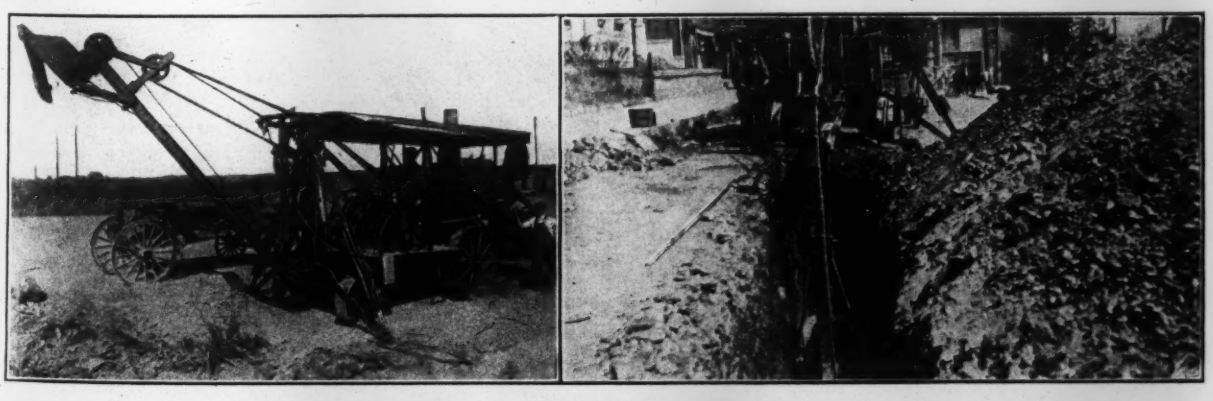
For regular steam-shovel work a dipper scoop is provided, and on this service the shovel will take down a 12-ft. bank. Used as a dirt loader and grader on road work, it can cut from a few inches to 5 or 6 ft. and for this work is fitted with what is termed a skimmer scoop of ½-yd. capacity. As a ditch digger the machine is backed away from, and in line with, the center of the ditch. In fair material it will excavate to a depth of 10 ft., depositing the spoil on either side of the ditch.

The excavator weighs but 19,000 lb. It is self-propelling, having two speeds—of 1 and 3 mi. per hr.—the propulsion machinery being the same as that furnished for many years on the Keystone well-drilling machine. The engine has 8x8-in. cylinders and a link reverse controlled by a rod and hand lever from the operator's platform. The boiler is suitable for either wood or coal, and the water tank holds 75 gal.

The boom, 16 ft. long, made of two 7-in. 15-lb. I-beams, swings through an arc of 180°. The hoisting cable is of ⅝-in. wire rope or cable chain, as preferred, and the sheaves are 16 in. in diameter. The machine is 18x7 ft. in plan (without the boom) and 11 ft. high.

This is a two-man machine. Under ordinary circumstances a single operator can handle it on the road or on the job; but if the wagons arrive steadily enough to keep the shovel in constant operation, a second man will be required to fire the boiler, assist in placing the blocking, etc. The scoop can be filled, raised and dumped in about ½ min. and will fill an ordinary dump-wagon in 2 to 3 min.

To get in position for work, the machine is moved so that the front end is about 6 ft. back from the material to be moved. The boom will then cover the field of operation of the scoop. The rear wheels should be blocked to prevent the machine from being shoved backward as the scoop is forced into the material. The bracing jacks at the front of the machine are then extended until the feet are solidly on the ground, and dogged.



FIGS. 2 AND 3. LEFT—BOOM RAISED TO HIGHEST POINT; HINGED BOTTOM OF SKIMMER SCOOP OPEN. RIGHT—DITCHING AND SIDE-CASTING

To operate the skimmer scoop for highway grading, the scoop is slid back to the inner end of the boom, which is in horizontal position. The hauling-drum lever is thrown forward, and the scoop moves along the boom until filled. The boom and scoop are raised to the height necessary to clear the wagon or dump-car, when the scoop is swung round and dumped. The bottom is thrown back in place and latched by a second pull on the trip line.

When the dipper scoop is used, the machine has to be moved up every 4 or 5 ft. Where the embankment is more than 6 or 7 ft. high, this scoop is more effective than the skimmer.

The ditcher scoop serves for digging in front or on either side of the machine. For trenches up to 44 in. in width the scoops are made of widths to correspond.

The machine is built by the Keystone Driller Co., Beaver Falls, Penn. With complete equipment of tools and fittings, but without scoops or their attachments, it is priced at $2,750.

Wrecking an Old Water Tower

The old wooden tank and water tower shown in process of destruction in the accompanying views was at Dodgeville, Wis. The tower was 60 ft. high, with a spread of about 20 ft. at the base, and was of the old-style 12-post design. The cylindrical wooden tank was about 16x16 ft., of 20,000 gal. capacity.

The wrecking was done with a set of blocks and tackle, a team being attached to the pulling rope. The tank was first pulled off, with tackle attached near the top, as may be seen at the left. Then the tower was pulled over, as shown. It was badly smashed by the fall, so that the wreckage was readily removed.

The Des Moines Bridge and Iron Co., Des Moines, Iowa, did the work, after it had built a 50,000-gal. steel tank with hemispherical bottom on a steel tower 90 ft. high to the balcony. This firm has done similar wrecking in a number of cases where it has built modern steel structures. The foremen have displayed considerable ingenuity in carrying out the work without damage to other property, and in one case the rope was hitched to a switching locomotive.

Irrigation Module Devised for Constant Flow

By Jerome Barieau*

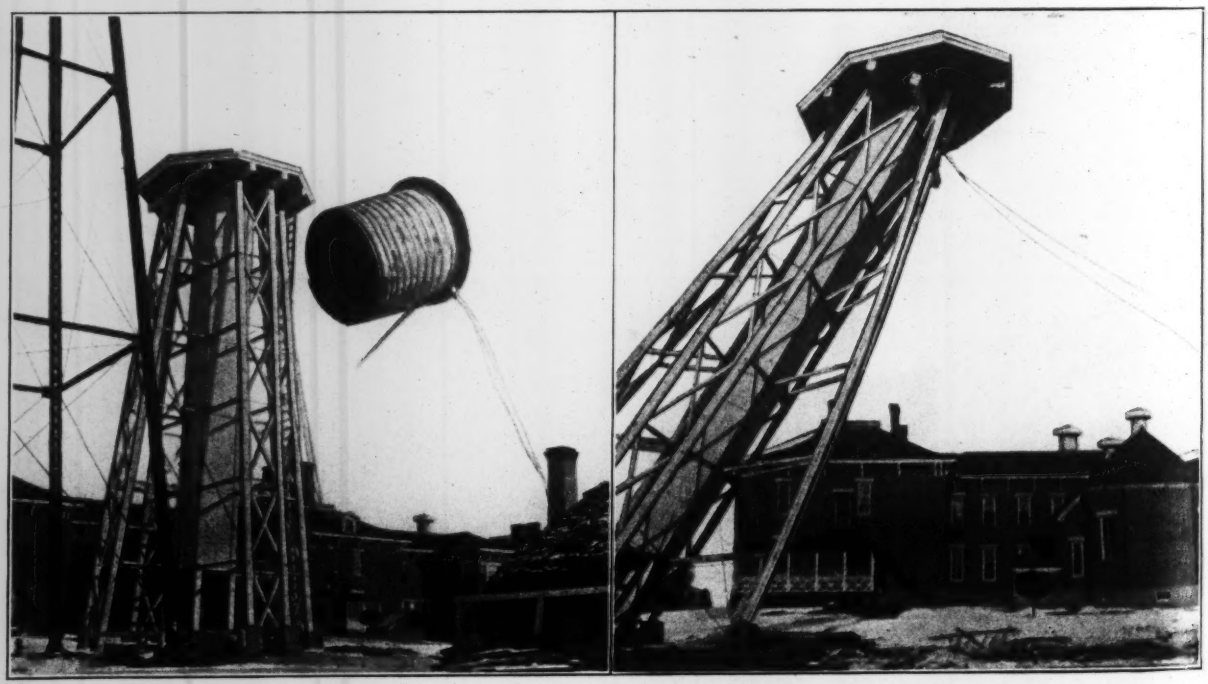
The constant-flow irrigation module shown in the accompanying sketch has been devised by the writer and has been used with great success by the Pacific Gas and Electric Co., San Francisco. It is an inexpensive device, since it consists essentially of a cast-iron base and a number of galvanized sheet-iron cylinders; no container box is required. Patents are pending.

Water enters the small inlet cylinder of the module through a T connecting with a 4- or 6-in. pipe from the irrigation canal. It flows down through the base, up between the weight and float cylinders and out to the consumer through the exit gate.

The float is formed by two cylinders partly telescoped and made air-tight at the top connecting wing, so that air is held in this gasometer above the water surfaces *A* and *B*. Three brackets permit the weight chamber to rest on a flange at the lower end of the inner cylinder of the float; all three cylinders of the float and weight chamber move together.

The large outer cylinder is a casing containing dead water, and it acts as a counterbalance to the water in the float, so that there will be no flow over the fixed inner casing cylinder. In the inlet cylinder is an air chamber connected by a ¼-in. galvanized-iron pipe to the gasometer and acting automatically with the latter—

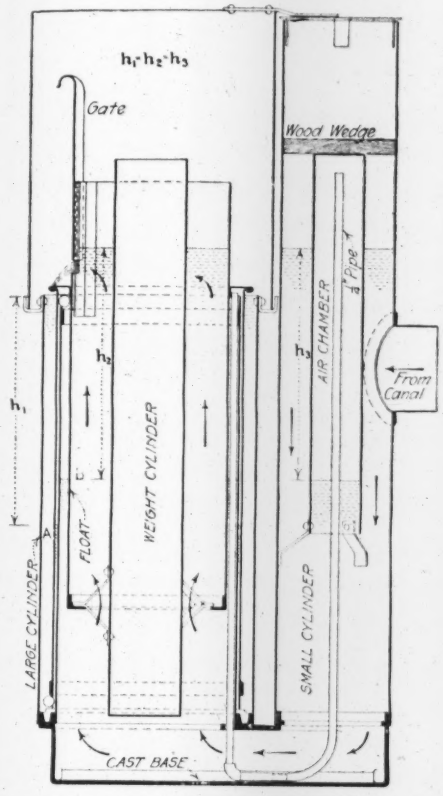
*3014 Grove St., Oakland, Calif.



WRECKING AN OLD WOODEN TOWER AT DODGEVILLE, WIS.

each giving or taking air according to the rise or fall of water.

The water surfaces in the inlet cylinder, float and canal are all at the same level. If the level rises, the weight cylinder acts as a float and the gasometer is raised proportionately. But as the gasometer rises, air



SECTIONS THROUGH CONSTANT-FLOW MODULE

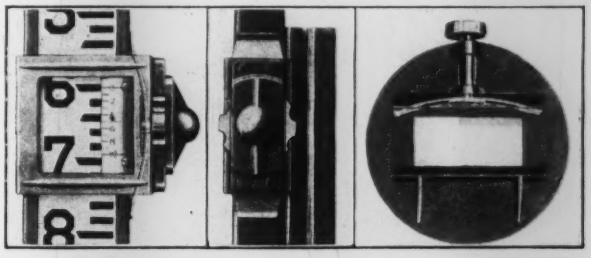
is automatically supplied by the pipe from the air chamber—keeping the air pressure constant in the gasometer. The size of the air chamber is such that the rise in water level supplies the proper quantity of air for the change in the gasometer. The device is designed to fail by expelling air when the outer cylinder of the gasometer rises to the level *A* of the seal water rather than by water going over the fixed inner cylinder.

Instead of the water flowing from an orifice it can just as well flow over the whole or part of the float circumference, thus giving a very small head loss where necessary; in an extreme case the module can be designed to work perfectly as a submerged weir with varying canal depths. Also, where the consumer has a pipe-line connection to the main canal this device can be used and the water automatically stopped whenever the consumer shuts off at the lower end. There is no case in actual practice where this module cannot be used; it also has no limit as to size and capacity. To make it free from meddlers, a hood is mounted over the float on four brackets and padlocked down.

The accuracy is indicated by the fact that no moving parts touch; the float carrying the orifice simply rises and falls in water. Rollers are put on the adjacent cylinders with a free play of ⅛ in. so that in case a cylinder does tip a little it will roll along easily. Experiments have shown that the rollers do not touch except in extreme high water or when the stability of the gasometer is below normal. With an ordinary size of module the head variation over the gasometer orifice never is more than ⅛ in. for a variation of 12 in. in the main canal. The module can be designed for any variation in canal level. If from year to year the consumer changes his demand, he is easily satisfied by merely the alteration in position of the exit gate, as the ordinary size will deliver quantities from nothing up to 20 miners' inches.

NOTES

An Improved Leveling Rod of the Philadelphia type is shown in the accompanying view. The vernier clamp A has the vernier set flush with its face and is held in position by a curved plate spring. A screw with cog-wheel head, shown at B, applies pressure at the center of the spring. This prevents binding and adds to the life of the spring. A cap protects the head of the screw so that it cannot fall out or be broken off. The target clamp C has a similar



DETAILS OF NEW LEVELING ROD

spring and screw arrangement, but the screw has a milled head. The sliding clamp is so designed as to give extra play to allow for expansion due to dampness, but at the same time to avoid a loose fit. The rod is of maple, finished in waterproof varnish and having hard enamel for the target and the background of the figures. The target has a dull finish to eliminate trouble from glare of light, and it has raised dividing lines to give a distinct definition. This rod is built by the Frederic Post Co., Chicago.

Cost of Street Paving in Amsterdam—The street paving of Amsterdam, Netherlands, has been relaid at a cost of 12,250,000 florins ($5,000,000). Cobblestone paving covers 1,100,900 sq.m. (1 sq.m. = 1.196 sq.yd.), costing 5 florins ($2.01) per square meter; brick paving, 2,750,000 sq.m., costing 2 florins ($0.80) per square meter; asphalt, 111,000 sq.m., costing 6.20 florins ($2.49) per square meter; and wood blocks, 38,000 sq.m., costing 12 florins ($4.82) per square meter.

The Relative Value of Central Mixing Plants, as compared with separated local plants, for the mixing of concrete for the New York subway was discussed by Robert Ridgway in a paper before the American Concrete Institute in Chicago. In the case of many of the contracts, notably most of those for the Lexington Ave. section, the contractors preferred to use central mixing plants, which were generally located along the East River, where the material could be brought to them by water, the concrete after mixing being hauled one-half mile or so to the work. Where motor trucks were used, the time consumed in transporting the mixture was not a cause for concern. Some of these trucks had a capacity as large as 4 cu.yd. On one of the sections air jets were used instead of water jets to assist in loosening the concrete from the truck in dumping. On several of the contracts concrete was hauled in horse-drawn trucks from the mixing plant. The time required was long enough to raise the question whether initial set was taking place before the concrete could be placed in the form, and it was necessary at times to reject some of the concrete when it was delayed too long in transit. Because of the trouble from this source the contractors then adopted the plan of mixing the ingredients dry at the central plant and delivering the dry mixture on the street at the work, when water was added and the mixture turned over twice by hand before being placed in the form.

Among the advantages of a central mixing plant are the following: Economy, especially when it is located on the waterfront; a minimum of inconvenience to the public and to residents along the line of the work and more convenient supervision of the whole operation of mixing. In spite of these advantages, however, Mr. Ridgway prefers to have the concrete mixed as close to the work as possible, as he believes that a better quality of concrete is insured when it can be delivered to the form immediately after mixing. On those contracts where the latter method is followed portable mixers are generally used, being moved from place to place as the progress of the work demands. This, of course, means that the street must be temporarily obstructed not only by the mixing plant itself, but by the piled concrete material that must be stored in the vicinity.

Backfilling a Washout on the Grand Canal, Salt River project, United States Reclamation Service, required some unusual earth-handling methods. The washout occurred at a point where the canal was curved out around a knoll and where it came very close to the river bank. The water, being deflected from the canal approximately at right angles into the river, scoured out a channel much wider than the original canal. It was necessary to do considerable backfilling as well as to close the breach, in order to restore the canal to its original prism. As the bottom of the canal had some soggy places, the time-honored methods of moving the earth for the fill with fresnos was not possible. Instead, the outfits shown in the accompanying views were used. First, the scrapers deposited the spoil on the edge of the fill; next, a six-mule plow was

BACKFILLING A WASHOUT ON THE GRAND CANAL, SALT RIVER IRRIGATION PROJECT

Top View—Plow team. Lower Views—Drag team

passed along the edge, followed by a six-mule A-frame of timber, like a road drag. The plow loosened the material, while the A-frame crowded it over the edge of the fill into the ditch. The scheme was admittedly not ideal, but it was about the only way the work could has been handled with the equipment available, which was that ordinarily provided for ditch building—plenty of mules and scrapers. The canal beyond this point is being relocated, cutting through the bluff instead of going around it. The project manager of the Salt River project is W. S. Cone, and the Construction Engineer is Walter Ward, under whose supervision the work was done by day labor.

Pavement Omissions—A peculiar Texas condition is shown in the accompanying illustration of a San Antonio street. The Texas state law guarantees every property owner his homestead; it cannot be taken for any debt or debts that he may incur. The homestead is likewise guaranteed to his widow unencumbered. This law has proved troublesome in the pav-

STREET IN SAN ANTONIO, TEX., SHOWING PAVING OMITTED IN FRONT OF HOMESTEADS

ing programs of nearly every Texas city; for unless the property owner will sign a voluntary lien on his homestead, there is no way in which he can be made to pay his paving assessment. Even such a lien is an encumbrance only if the property is sold, for it cannot be collected by an attachment on the homestead. The ordinary method of procedure is for the city to pay for paving the middle third of the street, leaving the property owner on each side to pay for his third. It is also general practice for the city to leave the collection of the assessments to the paving contractor, who then has to make individual contracts with every owner of abutting property. As the collection of the assessments is generally by instalments, a paving contractor in Texas requires both capital and a business organization. The result is that competition is limited; only the large corporations are ordinarily able to undertake the work, which probably adds at least 10c. per square yard to the cost of all pavements. It often happens that the owner of a homestead refuses to sign a contract or lien with the paving contractor, and then conditions like that illustrated come into existence.

Motor Traffic Affects Design of Arterial Highways—A condition has arisen within the last few years which has modified some of the principles regulating the laying out of arterial thoroughfares. It was formerly necessary to obtain such gradients on these main thoroughfares that large loads could easily be conveyed in the ordinary horse-drawn vehicles. The development of motor-driven traffic has considerably lessened the importance of securing very low gradients. It is still true that, for traffic purposes only, level-grade streets are best, and it is still the duty of the engineer to secure as near an approach to such a level grade as may economically be possible. The minimum grade which has heretofore been considered necessary in this city [Seattle] for such thoroughfares is 3%. In the Municipal Plans Report of only five years ago, for instance, an elaborate plan is suggested for cutting down the grade of Stone Way north of Lake Union from the existing rate of 4.7% to 3%. In my judgment the incurring of any expense for such a purpose will never be justified under the new conditions which have arisen since this report was made. With the motor truck the load is not limited by any reasonable grade, as in the case of the horse-drawn vehicle. The steeper gradient simply means the consumption of a greater amount of gasoline; but the central fact remains that the load, however great, is carried along without stoppage. If a team too heavily loaded approaches the steeper grade, it must necessarily stop and unload a portion before it can proceed, or secure additional teams to pull it over the hill. In other words, the rate of grade limits the load. With the motor truck the gears may be changed, but the load is not limited except by the capacity of the truck. I have therefore in the laying out of arterial thoroughfares adopted a rate of 5% as a maximum gradient. The change from a maximum of 3% to a maximum of 5% very greatly increases the ease and facility of locating these streets and makes it possible to obtain them in many cases at far less expense.—1915 report of A. H. Dimock, city engineer, Seattle, Wash.

Editorials

Perspective Often Preferable to Right-Line Projection

Sticking to the iron-clad tradition of right-line projection for working drawings is not always good. The simplest or most effective way to show a structure may be the use of an elementary perspective or isometric or other diagonal projection. Two samples shown by drawings are taken from present-day practice; they demonstrate that it is possible to combine a great deal of detailed and fully dimensioned matter in such a drawing. An example from the practice of 50 years ago was found in the case of the old Lake Shore trainshed illustrated in *Engineering News*, Aug. 20, 1914, pp. 402 and 403. Probably the method was much more common in those days than it is now.

Some skill and ingenuity is desirable—or essential—if perspective representation is to be fully successful. The device of cutting out a corner to show interior structure, as employed in the sketches of the Ohio Highway Department shown on another page, is a case in point, for without this little trick the construction and reinforcement of the headwall would be much less clear. But the necessary skill is not hard to acquire; it only needs some practice. Such practice is well worth while, the more so because its results are permanent, like the knack of skating or swimming.

A somewhat different use of perspective was shown last week (p. 738) in abutment standards of the Michigan Highway Department. The dimensions and working information were given by right-line projection, but a perspective was added to give a clearer understanding of the shape of the abutment. This method obviously is feasible even in case of complicated structures, where it is not possible to give dimensions and details on the perspective itself.

Activated-Sludge Problems

Will the sewage-sludge problem ever be solved? This question is prompted by the very interesting and suggestive observations elsewhere in this issue on the results being achieved and difficulties experienced at no less than six of the notable activated-sludge plants of working-scale size now being operated and studied in various parts of the country. The observations have all the more force because they are made by the engineer in charge of one of the activated-sludge plants included in the survey.

An attractive feature of the activated-sludge process is that the sludge itself is used as a contact medium in place of sand, broken stone or slag to aid in oxidizing the sewage and reducing it to a nonputrefactive state. The sludge itself, however, remains for final disposal. Its water content being high, as Mr. Hammond points out in his article, its final disposal is a problem to be reckoned with. This is all the more true if it is finally going to prove to be feasible to reduce the sludge for use as a fertilizer base, for then its moisture must be reduced to 10%. Mr. Hammond, therefore, makes the very interesting suggestion that preliminary screening for the removal of a portion of the sludge and the consequent reduction in volume of the amount to be treated may be desirable. This possibility is certainly worth the careful consideration being given to it at Brooklyn.

It may prove to be a nice problem to determine, and perhaps one to be determined at each plant—the volume of sludge that can be removed by screening and still leave just enough for satisfactory activation. Very likely there may be some localities where it will be more satisfactory to dispose of the whole volume of sludge after activation rather than to try to reduce the volume by preliminary screening.

However this may turn out, it is a most interesting illustration of the apparently never ending complexity of the sewage-disposal problem. New processes come and go; but notwithstanding their number and the high promise of some of them to be self-contained and all sufficient, sooner or later it has thus far always proved to be the case that if a high degree of treatment is required it is often far more advantageous to combine two or more processes or elements of treatment than to attempt to do all the necessary work with one.

If it proves to be advantageous, in some cases at least, to lessen by screening or otherwise the volume of sludge that gets into the activation tank, may it not in somewhat like fashion yet turn out to be desirable to have an after or finishing process for the effluent from activated-sludge works? It is, or seems to be, true just now that whatever degree of treatment may be required can readily be obtained by activation, but a considerable division of labor here as elsewhere in sewage treatment may yet prove to be well worth while, at least for particular localities.

The activated-sludge process combines clarification, oxidation and bacterial reduction in a single tank or series of tanks. These processes may be carried to almost any degree desired. The great question at issue is that of cost, although there may be various difficulties to contend with besides that of final sludge disposal. Two great elements in cost are sewage-holding or tank capacity and volume of air supply required, the first being dependent on the last and both hinging upon the degree of treatment required to meet the local conditions of any given case. There appears to be no serious difficulty in providing requisite tank capacity, although just what this is and the best size and shape of the tank have not yet been fully determined.

The air supply seems to be the critical matter. Associated with it is the provision of just the right sort of machinery for forcing and distributing or diffusing the air through the sewage.

Judging from Mr. Hammond's observations, by far the most uncertain air question is the one of distribution. It will be noticed with interest, perhaps with surprise by many, that Mr. Hammond is strongly of the opinion

that pipe-grid distribution promises to be far better than distribution through porous plates or disks. Surprise at this may be natural, but Mr. Hammond's opinion has an established basis. For instance, in air-lift pumping, it has been shown that the details of the foot nozzle have not the great effect once contended; if tiny bubbles are released they quickly coalesce and pass upward, growing larger and larger. Why, then, use plates if their chief claim is for more minute air diffusion, especially if they give rise to troubles of their own making? It will be interesting to know the extent to which other observers concur in Mr. Hammond's conclusion in favor of pipe grids.

There are of course other activated-sludge problems than those mentioned. Some of these are interestingly discussed in Mr. Hammond's article, and others must remain for consideration at another time.

Centrifugal Pump Overtakes Triple Expansion

The centrifugal high-duty high-head water-works pump at last, after a few years of sharp competition, has caught up with its rival—the triple-expansion pumping engine—in efficiency of performance. It is hardly more than two years since the centrifugal-pump designers really broke into this field and supplied such units as the two 20,000,000-gal. 145-ft. units for Philadelphia, two 24,000,000-gal. 268-ft. units for Toronto, one 100,000,000-gal. 56-ft. unit for Pittsburgh and perhaps half a dozen more of similar capacities scattered about the country.

Previous to three years ago a duty of 80,000,000 ft.-lb. per 1,000 lb. of steam was a highly creditable performance for a centrifugal-pump unit. It was not a bad record for a reciprocating machine. The 100,000,000-gal. steam-turbine centrifugal unit at Ross station in Pittsburgh jumped up to something like 120,500,000 ft.-lb. Then the Kirtland-station 30,000,000-gal. pump in Cleveland carried the record along up to 152,020,000. Now comes the Montreal 31,000,000-gal installation with a record of 155,356,000 ft.-lb. per 1,000 lb. of steam—and there is no reason to believe that the end is quite yet.

It is interesting to compare this two years' progress with the history of the large high-duty triple-expansion engine with which the centrifugal pump has been competing. In its early days, say 1886, the former held a record duty of about 122,000,000 ft.-lb. per 1,000 lb. of steam. This went up to some 154,000,000 by 1892, to 181,000,000 in 1906 and 195,000,000 in 1909. Probably the best figure yet recorded is 202,629,000 ft.-lb. per 1,000 lb. of steam—made in 1914 by the 20,000,000-gal. Bissells Point triple-expansion engine in St. Louis. However, these last two jumps lose their significance when the superheat of the steam supply is discounted.

For useful comparison of all these modern pumping units the old 1,000 lb. of steam basis is inadequate, due to use of superheated steam, and has been employed here only because the earlier available records are so expressed. To get to a rock-bottom base it is necessary to quote foot-pounds per 1,000,000 B.t.u. On this basis the Bissells Point engine record is 166,719,796 ft.-lb. *and the new Montreal centrifugal performance is 168,300,000 ft.-lb.* Incidentally, the thermal efficiency of this turbine-and-pump unit is about 21.4%, compared with 25% for the best recorded quadruple-expansion engine alone.

What Makes It Rain?

The heavy rainstorm that visited San Diego County, California, on Jan. 27, destroying the Lower Otay dam and doing a vast amount of other damage was without a precedent in the history of that section. As most of our readers are aware, this southwestern corner of the United States has a greater variation in annual rainfall than any other section of the country. A drought continuing over three successive seasons, during which not enough rain fell to produce any material flow in the streams of San Diego County, occurred only a few years ago. The question of a safe water-supply to tide over such long droughts of uncertain duration has long worried San Diego. In all the 20 years since the Lower Otay dam was built there has never been rain enough to fill the reservoir behind it until the recent storm came.

The rains of the past winter were unusually delayed, and there probably was some anxiety lest the entire winter season might pass without additions to the stock of stored water. At any rate it appears that some time before the January storm the City Council of San Diego arranged with a professional "rain maker" to go into the mountains back of the Moreno reservoir (one of the main sources of the city's supply) and there work his incantations or whatever machinery he uses. It appears further that the rain maker was to have a fee of $10,000 if he produced rain enough to fill the reservoir.

Whether the city councilors really believed in the rain maker's power over the clouds or whether they accepted his proposition as a joke, thinking it entirely safe to promise the man $10,000 to fill a reservoir which had never been filled and the water in which would be worth several times that sum to the city if filled, does not appear. However that may be, the rain maker now claims to have done his job; and if anyone believes that his operations produced the storm of Jan. 27, it is clear that he not only did his job, but greatly overdid it.

At last accounts the City Council had refused the rain maker's demand for his $10,000 fee, on the advice of the city's attorney that the contract was only an oral one and therefore illegal and not binding under the city charter. Next time the council lets a contract for rain production it will doubtless be particular to specify the exact number of inches wanted and will require of the contractor a bond to indemnify the city from damages in case the contractor pulls the clouds too hard.

The whole story is a new illustration of the extent of popular ignorance as to the causes of rainfall. Older illustrations are plentiful. Many readers will recall an appropriation by Congress a quarter-century ago to enable an inventor named Dyrenforth to experiment in rain production by firing cannons on the plains of Texas. More recent still are the associations for warding off hailstorms in the Alps by firing cannon and the sending out of a special "rain-making car" to the drought-stricken people of western Kansas by the Rock Island Ry.

The engineer makes more use of rainfall records than the men of any other profession. Much of his work depends for success on the amount of rainfall and is subject to destruction by an excess. In order to make any satisfactory reply to the question whether artificial rain production is a possibility it is needful to know the causes which produce rainfall.

It seems worth while to state here, therefore some of the elementary facts regarding the causes of rainfall which are well known to experts in meteorology, but not so well known to the general public and even to many engineers.

In the minds of most people living in the humid climate of the eastern United States and of western Europe the idea is firmly fixed that the ordinary course of nature is to produce rainfall distributed at fairly regular periods throughout the year. A long-continued drought and a long period of heavy rainfall are alike regarded as abnormal departures from nature's regular course.

But when one goes to the Pacific Coast with the established idea that it is nature's business to keep the streets sprinkled, the farms watered, and the brooks and rivers flowing the year round, he finds this unconscious belief completely upset. In California, nature disclaims all responsibility for the growing crops or the water-supply of cities. She pours rain upon the earth in the winter months—scantily in the south and liberally in the north—but from spring until fall, not a drop of water comes from the sky.

When the Easterner inquires concerning the reason for this strange departure from the beneficent operations of nature to which he has always been accustomed, he learns that the Pacific Coast is a great laboratory where the causes of rainfall, which are a blind mystery to dwellers in the East, are annually demonstrated in a manner too plain to be mistaken.

It is of course evident to everyone that the great original source of rainfall is the ocean. All the water that is discharged by rivers into the ocean has come originally from the ocean in the form of moisture-laden winds. There is some evaporation from land surfaces, but it is very small compared with that from water surfaces. The air over the ocean is always heavily charged with moisture; but as the capacity of air to hold moisture varies greatly with its temperature, the winds blowing over the warm ocean water of the tropics hold much more water than the winds blowing over the cold oceans of northern latitudes.

The key to a clear understanding of the causes of rainfall can be very simply stated: *Wherever moisture-laden winds from the ocean are cooled as they blow over the land, to a degree sufficient to condense the moisture, rain will result.*

Apply this key in a study of the Pacific Coast climate. At the extreme north the warm water of the great Japan current, carrying with it warm winds heavily laden with moisture, follows along the coast of Alaska and British Columbia. In this far northern region the land is of course cold, and the result is heavy fog and frequent rain on the coast and an enormous snowfall on the high mountains just back of the coast, as at the White Pass, for example. Along the coast of British Columbia the mountains are close to the sea, and the annual rainfall reaches 150 in. or more at some places.

As one proceeds farther south, however, a latitude is reached where the land is warmer in summer than the ocean and the winds that blow from it. In the valleys of western Oregon there is seldom rain in summer, although rain and snow fall on the cold summits of the high mountains. The water of the Pacific Ocean all along the coast of Oregon and California, even as far south as San Diego, is very cold, and the winds that blow from it are cold and not as heavily charged with moisture as winds from warm tropical waters. Only in the winter months, therefore, is the land over which these winds blow cool enough to precipitate rain. The farther south one goes, the shorter is the rainy season and the less the average rainfall.

On the coast ranges of northern California there is a very heavy winter rainfall, and the redwood and sequoia forests flourish. In the vicinity of San Francisco the annual precipitation is some 20 in.—varying greatly, however, within short distances, according to altitude and exposure. At Los Angeles the average is 15 in., with a far heavier precipitation in the mountains—at an elevation of 3,000 to 5,000 ft.—only a dozen miles away. At San Diego the average is only 9 in., although here again on the high mountains 40 to 50 mi. back of the coast—at elevations above 5,000 ft.—30 in. of rainfall or more has been recorded. Going still farther south, on the long narrow peninsula of Lower California, although it is surrounded by ocean waters and in a southern latitude, the rainfall is scanty and uncertain even in winter, for even at that season the land is seldom cold enough to condense moisture from the winds that blow over it from the adjacent ocean.

An illustration from the opposite side of the globe is found in the moist winds that sweep over the plains of India from the Indian Ocean. These plains are so heated by the tropical sun that little rain results, and irrigation is necessary for agriculture over vast areas. But when these winds, after passing over the plains, strike the Himalayas, they are suddenly cooled; and the annual rainfall in these Himalayan foothills is as great as that recorded anywhere in the world. In the Nicaraguan isthmus similar conditions prevail.

One of the questions that engineers have spent much time in discussing is whether forests increase the amount of rainfall. The intelligent way to study this matter is to consider whether the presence of a forest can materially increase the cooling effect of the land on a passing moisture-laden wind. The amount of heat received daily from the sun on an acre of land, it must be remembered, will be exactly the same whether the land is forested or bare; and except for the trifling percentage of heat absorbed by the forest in its growth, the total amount of heat given off by radiation and conduction must be the same in each case, although there may be some variation in the distribution of this radiated heat through the 24 hours of the day.

If we seek the causes of such torrential and unprecedented rains descending upon a usually arid region as that which recently fell in southern California or the storm which wrought such destruction at Monterey, Mexico, a few years ago, we must find them in the course of moisture-laden winds from the ocean. In our issue of Jan. 6 appeared a map, prepared by Allen Hazen, showing the variation in annual rainfall in various parts of the United States. As was there shown, the whole United States east of the Rocky Mountains enjoys a fairly regular rainfall, while the Pacific Coast rainfall is irregular.

It is probable that the ultimate reason for this is to be found in the ocean trade winds that sweep across the Atlantic heavily charged with moisture, pass on inland over South America, giving to all the vast area of Brazil

from the coast back to the Andes a profuse and regular rainfall, and in North America sweep northward from the Gulf of Mexico over the entire Mississippi Valley. On the Pacific Coast, as soon as one passes south of British Columbia, where a heavy rainfall is produced by the warm winds that accompany the Japan current, no such regular shoreward sweep of warm ocean winds exist. It is the variable winds of the Pacific Coast, therefore, which produce the variations in its rainfall.

As to the causes of these variations, they are too numerous and complicated to yield to systematic analysis, at least in the present state of scientific knowledge. Such elementary things as the shoreward breeze in summer, when the highly heated land is sending a current of warm air aloft like a huge furnace, one can indeed understand; but more complete information about the ocean currents—of water and of air—is necessary for that broader knowledge on which prediction can be based.

What does seem clear, however, is that until man—this small insect crawling over the earth—can find some means to change the course of the winds of the air and the rivers of the sea, his acts can have little influence on the fall of rain.

Co-operate, But to What End?

The high-motived gathering of engineers at Chicago last week known as the Conference on Coöperation met for the broad purpose of securing coöperation—and nothing more. Those who came to attend wished to coöperate as engineers, somehow; they knew not how. The precise What had not taken form in their minds. They came without tangible purpose, except to coöperate. They went apart with no more definite purpose: To coöperate, somehow, in the future. That is regrettable.

Coöperation is good when it has a useful purpose. It is not in itself a purpose. Conceding all due respect to the earnest optimism of the conferees, it remains true that coöperation alone and unvitalized is an empty husk. By all means coöperate, but to what end? Let the end be apprehended clearly and made known!

The men of the conference were moved by strong and true motives—that is certain. They felt doubtless that there is need for a new school, a professional regeneration quite different from tinkering with existing formalism.

We engineers are in the grip of the times, and they are times of change. The unrest of shifting conditions has stirred us. We feel troubles coming to add to troubles already upon us. The individual who turns to his technical societies for counsel and help finds these societies static and supine, not to say torpid. Possibly Professor Newell and his coöperators were actuated by appreciation of these facts.

It is true, we engineers all—or most of us—are ensnared in the same perplexities. If there is today a greater degree of misunderstanding than ever before between engineers and engineers, and between engineers and laymen—especially those who shape our government—this unfortunate state affects us all. We may as well come together, either to mourn jointly, which is vain, or to plan unitedly for reconstructive action within and without the profession. There is logical basis for coöperation, if purpose backs the coöperation.

The forces that brought about the conference are a symptom of the period. Symptoms are of use only for diagnosis; unless employed in locating the seat of the trouble they are of no service. The Chicago group failed to reach a diagnosis. In meeting for mere abstract coöperation it emphasized the symptom without getting nearer to diagnosis or proper curative treatment.

Is it possible that we need an engineering organization that shall be the individual engineer's society, whose main care shall be the lone individual devotee of the engineering profession? The lack of influence and power of the profession in the aggregate may be simply the resultant of the weakness and helplessness of each individual one of its members. If this is the case, then to strengthen the profession we must strengthen and help the individual.

How far have existing coöperative movements—that is to say, the present societies—helped and strengthened the engineer? There are the honor societies and the work societies; the publication societies, which record and educate; the social societies, which entertain; the commercial-aid societies, which promote and regulate industries and incidentally protect the public and save waste of money. None of these have given more than trifling help to the individual engineer. He is in these societies nothing more than a pawn. He should be—or might be—the king, the whole object of the game. The society that shall exist only by, for and to the individual engineer has yet to be created. Is it possible? Is it desirable?

As the world advances, so also, it may be assumed, does the engineer advance. The most optimistic view of this advance, however, cannot fail to notice much that is the very opposite of advance. Complications of many different kinds arise to obstruct the activities of engineers, injure the good repute of the profession and make the individual's professional existence more precarious. These complications will not take care of themselves. A leave-alone policy is a suicidal one for the engineering community to pursue. It must take up each case and grapple with the difficulties.

The past year—to go no farther back—has brought specific examples of serious trouble in the engineer's existence and work in quite different sections of the country. The East, the Mississippi Valley and the Coast have all had their bad cases, and some of these are pending even today. They are the large matters, as legislative over-riding of the engineer's claim to existence and recognition, destruction of the business basis of technical work by introduction of dispensary methods, engineering negligence in large matters to the discredit of the profession, usurpation of important technical functions by administrative officers to the injury of the public's and the engineers' interests, and the like. Smaller matters of the same and other kinds number legion. All have been left untouched—yes, have been deliberately ignored—by the existing societies of engineers. And all of them are beyond the power of the individual engineer to combat unless he has the support of a broadly conceived coöperating body that makes his interests its own.

It cannot be impossible to focus the scattered motives and purposes in the Coöperation Conference into a strong, directed program. The moving spirits in the enterprise are in a position to achieve this result.

Letters to the Editor

Validity of the Pile Formula

Sir—Referring to Mr. Thompson's letter under the title "Pile Formula Misinterpreted," in your Mar. 2 issue, permit me to suggest, without any intention of questioning the well-known value of the *Engineering News* formula, that the impression conveyed (implying that results by this formula are actual) may be very misleading in cases where one is not familiar with the possible variation. In this connection Professor Baker, in his "Treatise on Masonry Construction," demonstrates that under certain conditions the formula gives infinity when solved for load capacity.

Mr. Wellington, who devised the formula, pointed out that an increased resistance or decreased set of the pile per blow, resulting from an interval of rest, would develop increased skin friction due to earth settlement around the pile, and to compensate for this at the moment of impact he provided the constant c in his formula. Use of a constant to meet the widely differing earth textures and pressures and their consequent differing mobility involves an apparent uncertainty in the results obtained.

The true value of this formula will be appreciated most fully when the ease with which it can be equated with an actual load test is known. It is not unusual for building regulations to require a test load, and specifications frequently call for one or more. These, however, are not generally carried to the point that would establish the real factor of safety involved, which should be done if the same known stability that is required in the superstructure is to be maintained; and it is certainly no less important to have this exactness in the foundations than in the construction they support.

In the following example I have used required load capacity, by which means very accurate results are obtained; but very close results may be secured by assuming a load capacity less than the required one, whereby very heavy test loads are avoided, and then following the method outlined. It should be kept in mind that skin friction will not be fully developed until some time after driving; also that in driving concrete piles several methods more or less disturb the earth friction, by the withdrawal of driving forms after desired penetration is obtained. In some cases of concrete-pile driving the use of an enlarged point greatly reduces the friction while driving. In these instances the apparent greater amount of driving energy used to displace earth at the point will give higher load capacity when the earth friction is developed by a period of rest than where no such enlargement is involved. The time allowed for this development of skin friction will naturally vary according to conditions, but ordinarily a week is amply sufficient.

As an example, let it be assumed that the formula has been solved for penetration to support a load of 50 tons, using a steam hammer with ram weighing 5,000 lb. and normal stroke of 42 in., the result being four blows to an inch set. The constant c is here taken at 0.1, as usual with the Wellington formula when using a steam hammer.

Now a test pile should be driven until the mean of the sets for a number of blows, when the penetration has been at a uniformly decreasing rate, agrees with the foregoing solutions of the formula—namely, four blows to the inch.

Let it be assumed that, under test, settlement starts with a load of 300,000 lb. (Observe that, as generally used, the formula is intended to give a factor of safety of 6, because if 12 times the weight of the ram were used instead of 2, the load capacity given would be ultimate.) Accordingly, the test shows the factor of safety to be less than was intended by the formula. The formula is now to be solved for the new factor of safety or, more simply, for the actual value of the quantity to take the place of 12, after which the factor of safety is plainly accessible, as follows:

$$300{,}000 = \frac{f \times 5{,}000 \times 3.5}{0.25 + 0.1} \qquad \text{or } f = 6$$

Substituting this value for 12 in the formula and equating with the ultimate load capacity required under the formula, the following results:

$$600{,}000 = \frac{6 \times 5{,}000 \times 3.5}{s + 0.1} \qquad \text{or } s = 0.075$$

or required penetration equals $^3/_{40}$ in., or $^3/_8$ in. to 5 blows.

It will readily be seen that by this method actual physical conditions are made to govern the load capacity rather than leaving it dependent upon the uncertainty of calculation as governed by empirical formulas. It will be found that the same method can be applied to other formulas, but with more or less complex mathematical work, the absence of which is always desirable.

The assumed load causing settlement was taken at 300,000 lb. in the given example to make the working of the equation plain at a glance; but it should be remembered that in practice this quantity may be made up of various figures.

CLARENCE S. HOWELL.

550 West 174th St., New York City, Mar. 11, 1916.

Is Development Invention?

Sir—In *Engineering News*, Feb. 17, 1916, there appeared an editorial which contained the following paragraphs:

> To most engineers engaged in reinforced-concrete construction it seems exceedingly strange that some of the patents on reinforced-concrete construction should ever have been issued by the Patent Office and stranger still that these patents should have been upheld by the courts. The same thing is true of a number of other patents that interfere with the free work of engineers in design and construction, such as some of the patents on sewage disposal and on road construction.
>
> The position of engineers with regard to the class of patents referred to is that the patents are not on a real invention, but on a particular way of doing something; and they believe further that the state of the art when the patent was issued was such that the patents should be declared void by the courts for lack of novelty.

You made it plain that, in your opinion, patents interfere with free work and that they are not patents on invention at all, but more on the way of doing a thing. Can't you look at this more broadly?

Every once in a while a new and better way of doing an old thing is developed. Traced back, this better way is usually the product of hard, sustained, original effort. In practically every field of commerce and industry society recognizes and rewards such efforts by granting to the developer the exclusive right to the development for a limited number of years. This privilege, granted as a patent, acts not only to encourage original effort, but also enables the patentee to enlist capital for the development of his idea, so that it may be of use to society.

Such is the case in practically every field of industrial endeavor. Applying the same principle to engineering and construction—where the operation is in big units, where the operation cannot be one of individual production and sale—what protection and encouragement can we offer engineers for really working to develop new ideas, new and better ways of doing things?

Take our own case, for instance. We were concrete engineers, designers and erectors of reinforced concrete. In 1906 the Cleveland Furnace Co. needed 1,000 ft. of dock on the Cuyahoga River. Our first plan for this dock, prepared at the company's request, followed accepted practice in dock design, practically a heavy mass-concrete buttress, pile supported and tied back into the shore with iron rods. The cost was estimated at $65 per lineal foot. At this price there was nothing doing. It was put up to us to get a good dock for less money. We analyzed our problem and found that we had to meet the following conditions:

1. We must build a dock wall in such a way that it would not interfere with the natural flow of the water and the bed of the water.

2. This dock wall must be so constructed as to resist heavy strains from the ships that would come in contact with its outer edge and moor at the dock. Then, too, it must resist the heavy impact thrusts of a loaded iron-ore boat that might strike it.

3. The dock wall must carry heavy loads without tending to slide out into the water.

Reinforced concrete offers permanent low-cost construction, strong without mass, fireproof, rustproof, rotproof.

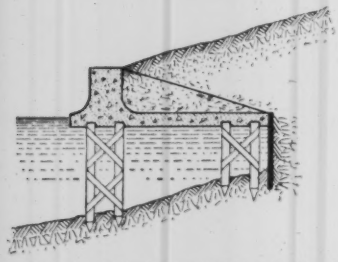


Fig. 1—Original sketch, 1906.

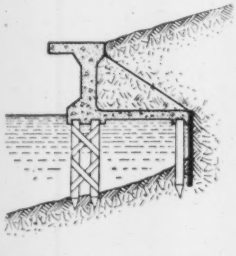


Fig. 2—Final sketch, 1906

FIGS. 1 AND 2. FIRST AND FINAL DOCK WALLS OF CLEVELAND DOCK ENGINEERING CO.

We had specialized in reinforced concrete and usually saw things in terms of that material.

We went at this problem as thoroughly as we could. The technical libraries were combed for all the information on dock construction we could get. Finally, out of the mass of preliminary sketches and studies we evolved a different structure, what seemed to us to be a fundamentally new idea in dock design and construction.

The accompanying sketches show how this idea grew. Fig. 1 is the first definite study. The idea was to make the fill take the place of the mass concrete and to tie the dock back into the land by a reinforced-concrete floor.

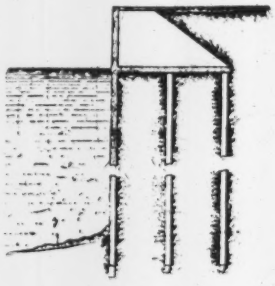


Fig. 3—Patent drawing, 1897

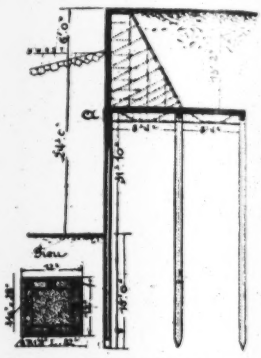


Fig. 4—Wall at Southampton, 1898

FIGS. 3 AND 4. HENNEBIQUE PATENTED DOCK WALL

Leaving out mention of several intervening studies, we finally arrived at a design about like that shown in Fig. 2.

This study developed a great horizontal girder to withstand impact thrust. The dock wall was essentially a giant I-beam with the lower flange on the shore side extended back indefinitely to a tight wall on the shore. The web and upper flange were braced by heavy buttresses 14 ft. on centers. The piling required was minimum, the floor of the river was unobstructed, a tight wall at the shore edge kept the fill dry and the greater the load the greater the stability of the dock wall. The cost of this wall, as originally submitted in an informal proposal, was about $23 per foot, about one-third of the original mass-concrete design that followed accepted standards.

So far—so good. Our design looked good from an engineering and from a financial viewpoint. But it was a new departure, an original development. Before our work was accepted, we had to build at our risk a 30-ft. test section. This was loaded with 600,000 lb. of pig iron. The load was concentrated in 4 sq.ft.—an area 2x2 ft. The settlement of the dock wall under this load was practically nil. The thing was a success. We had developed a new and a less costly way of building docks, a better way apparently.

There were some changes in the conditions—loads were increased and the concrete in the floor made heavier, with additional reinforcing steel, bringing the cost of the dock up to $28.40 per lineal foot. The 1,000 ft. of dock was completed in 1907. It has given satisfactory service every day since. The cost for upkeep has been practically nil.

Now, in view of the rather sweeping statements in your editorial that patents on reinforced-concrete construction are not real inventions and that they interfere with the free work of engineers just let me ask you what there is under the conditions which you apparently advocate to encourage original work on the part of the engineer. If we had been mechanics and our office a machine shop, if we had been chemists and our office a laboratory, the product of our earnest original effort might have been a unit or a definite process defined by set formulas. As it

was, our engineering office was our laboratory; the building site was our experiment station. We developed new methods, accomplishing better ways of doing a thing. Our work and the work of countless other engineers along similar lines have been just as true inventions as if they had been carried on with test tubes and scales.

We want to draw a distinction here and not try sweepingly to defend all reinforced-concrete patents, for many of them, just like many patents in any field, have been, as you say, entirely unjustified, for they have not been the result of honest invention, honestly developed. Isn't it true, though, that to a great extent all patents cover a way of doing a thing? Why should not designs prepared under and protected by patents be just as tangible a salable article as a piece of patented electrical equipment?

We believe that it would be much better for society as a whole to encourage by patent protection more efficient development of engineering and construction methods. In its best sense isn't a patent a trust, a trust from all the people to an individual? This trust should carry with it the moral obligation to use that patent for the good of the people, reserving a fair reward for effort, ability and inventive genius. As a patentee an engineer becomes essentially the trustee of a newer, a better, a less costly way of accomplishing a certain result. The patentee further becomes responsible for the proper development and application of this method. What would be everybody's business is nobody's business, and patent protection in the last analysis is simply a way of making one man responsible, holding him responsible and giving him every encouragement and aid in developing the better method.

Engineering News, instead of confining itself to destructive criticisms of existing conditions, might well see the situation in its broader aspects and help constructively to work out conditions which will in some way encourage original work, protect and reward the engineer who does original work.

J. D. CAREY,
Cleveland Dock Engineering Co.

Cleveland, Ohio, Mar. 27, 1916.

[In answer to the essential criticisms of Mr. Carey, criticisms which seem to be in nowise justified by the editorial paragraphs quoted, we can only repeat that

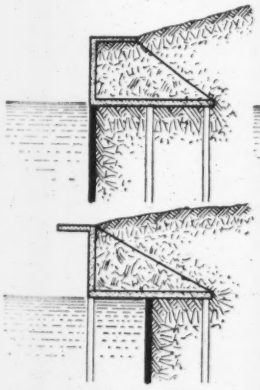


FIG. 5. COMPARISON OF HENNEBIQUE AND CLEVELAND WALLS

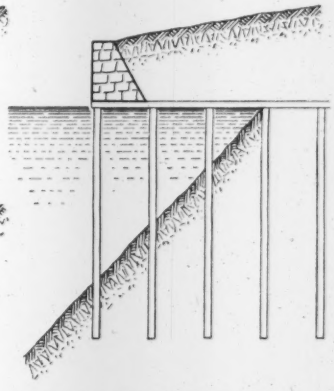


FIG. 6. TYPICAL MASONRY DOCK WALL OVER WATER

invention is necessary to a patent. Development work is taken into account when invention is assured or in doubt, but one cannot secure the monopoly rights in a method or device by study, tests, development or promotion, however arduous and lengthy, if the method or device is assuredly not original to the promoter.

It is in this particular that most of the reinforced-concrete structural patents are subject to criticism. In the decade from 1895 to 1905 a group of European engineers and contractors were developing on the Continent elaborate systems of reinforced concrete at a time when American engineers were practically ignorant of the exist-

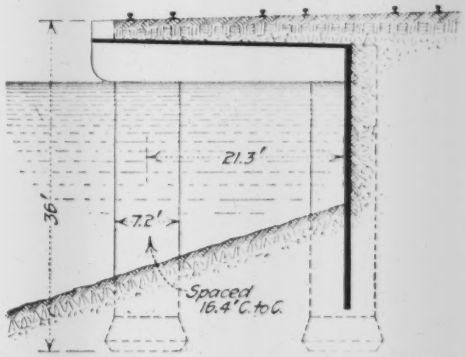


FIG. 7. DOCK WALL AT YMUIDEN, HOLLAND, BUILT BEFORE 1904

ence of such a material. The record of European achievement is fairly complete in foreign texts, so much so, in fact, that practically every American structure, though honestly thought to be novel by its supposed inventor, can be duplicated in French and German literature of one to two decades ago. Those that cannot be so duplicated can generally be shown to be but the result of an orderly process of design possible to any technically trained man. The existence of a previous similar design in any publication is a legal bar to a patent; the question of what is an orderly process of design and what is invention must be left in a specific case to the judgment of the court.

The dock-wall patent held by Mr. Carey's company (United States Patent No. 1,089,405) is a very good illustration of all these arguments. We do not propose to investigate the legality or technical value of that patent. It has already been upheld in the one lower court into which it has been brought, and the structure which it describes is by no means common. But Mr. Carey's letter gives rather a false impression of the addition to engineering science made by his company in its development of the dock wall for the Cleveland Furnace Co. and overemphasizes the novelty of the structure.

In 1897 François Hennebique received a British patent (10,203[97]) on "an improvement in piles, quays and retaining walls" in which appeared the drawing shown in Fig. 3. In 1898 the wall illustrated in Fig. 4 was built, after this patented design, at Southampton, England. This wall embodies every feature of the Cleveland wall except that of extension over the water. Whether such an extension warrants a patent only a court can determine, but the two sketches (Fig. 5) show clearly that Mr. Carey's engineers in their study of the wall were up against a problem in design rather than in invention. By moving the tight wall of sheet piles back from the face of the wall the upper, or Hennebique, wall becomes the lower, or Cleveland, wall in its essentials. Anything else in the later wall contains nothing beyond the elements of design.

Furthermore, the extension over the water was not new. Dock and quay walls of the type shown in Fig. 6 are of

very long standing. The difference between that wall and the one in Fig. 2 is merely one of material. The courts are not united as to whether in reinforced concrete the use of another material constitutes invention.

Even direct anticipation of the Cleveland wall can be found. The drawing in Fig. 7 is a reproduction from a paper read before the International Engineering Congress at St. Louis in 1904 and is sketched from a drawing in "Transactions" of the American Society of Civil Engineers, Vol. 54, A, 1905. It is a wall at Ymuiden, Holland, and possesses all the fundamentals of the Cleveland wall —that is, pile rows in the water supporting an earth-loaded deck extending back to a tight wall that retains the bank. It is of reinforced concrete.

All this does not pretend to be an exhaustive inquiry into the validity of the Cleveland Dock Engineering Co.'s patent rights. So far as we know, that company is more interested in designing and building structures than it is in collecting royalties—which is more than can be said of some structural patentees. But it does explain why engineers resent some claims of structural patentees.—Editor.]

Fire-Resistive Construction Being Developed

Sir—I was particularly interested in reading the timely and logical editorial in *Engineering News* of Apr. 20, 1916, p. 461, under the title "Incombustible Construction" because of its direct relation to two distinct lines of work upon which I am engaged. The first of these is a pamphlet which I have been preparing during the past year, dealing with fire-resistive construction and fire protection for dwellings. I expect to have this ready to issue in about three weeks, and I shall be interested in having your comments upon my method of treating the subject. The second activity to which I refer is that of the work of two committees upon fire-resistive construction—one in the National Fire Protection Association and the other in the American Society for Testing Materials. These committees, of which I happen to be chairman, are working along somewhat similar lines, though the latter committee deals only with standards for test requirements. The former committee has a membership of 17 experienced, practical and very active workers. They are architects, engineers and insurance men, all of whom have had years of training in the actual doing of things; and I may say that I never have worked with a more interested and conscientious body of men. This committee has adopted the principle of recognizing three grades of fire-resistive materials and construction, and following the plan of the British Fire Prevention Committee such materials or construction when properly employed would render "full," "partial" or "temporary" protection for the specific construction.

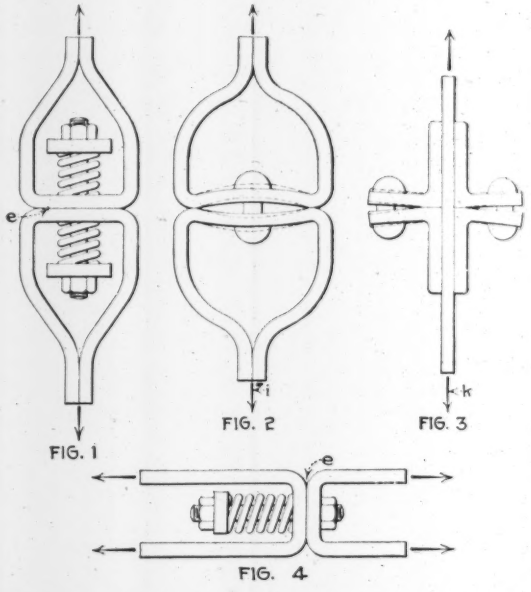
In harmony with this idea of recognizing different grades of fire-resistive construction the Committee on Fireproof Construction in the American Society for Testing Materials has recently accepted the same principle and in its future work will undertake to establish standards of tests for each grade. In order to secure the best results and avoid duplication or complication, in the work, an endeavor will be made to secure coöperation between the two committees.

I thought you might be interested in knowing that such work is in progress, since it is in line with the views expressed in the editorial previously referred to.

IRA H. WOOLSON
Consulting Engineer, National Board of Fire Underwriters.
New York City, Apr. 21, 1916.

Why Initial Tension in Rivets Is Not Serious

Sir—In your issue of Feb. 17, 1916, Jacob M. Friedland gives an analysis of stresses in rivets used in direct tension and apparently finds that tension tending to separate the parts adds very materially to initial tension on rivet heads. Mr. Friedland ridicules the statement quoted in your issue of July 22, 1915, from my book "Steel Designing," "A little analysis will show that



SKETCHES SHOWING HOW SPRING ACTION PREVENTS INCREASE OF INITIAL STRESS

pulling on the head of a rivet already in stress due to shrinkage does not increase the stress on the rivet, but relieves the pressure on the plates, unless the added tension exceeds that already on the rivet."

The analysis is simply this: In Figs. 1 and 4 there is no added tension on the bolt until the surfaces at *e* are separated, since the springs are not shortened; that is, until the reactions on these surfaces are exceeded or, in other words, until the original tension on the bolts is exceeded by the applied forces.

Mr. Friedland's analysis is at fault, because he assumes a rivet driven through a perfectly solid piece of metal. Rivets in reality hold together two or more pieces of metal which do not fit perfectly on one another. Their tendency to separate acts like the springs of Figs. 1 and 4, as illustrated in Figs. 2 and 3. The amount of this spring in the plates is so large in comparison with the almost infinitesimal thinning of the plate due to compression that the latter can safely be neglected.

It is conceded that if each head of a rivet were taken hold of by a pair of forceps, the increased tension would

be that exerted by the forceps; and if the tension could be applied by thin plates immediately under both heads of a rivet, a large increase in tension would result. But this is not the nature of structural details. A tension detail is usually only a part of a larger detail. The actual tension applied is usually local on a few rivets, while the resistance is general in the member to which attachment is made. Such detail corresponds to Fig. 4.

EDWARD GODFREY.

Monongahela Bank Building, Pittsburgh, Penn., Mar. 16, 1916.

Beware of the Dog!

Sir—Referring to the article in *Engineering News*, Mar. 30, 1916, on the collapse of the pony-truss bridge at Johnstown, Penn., I have had occasion several times to examine highway bridges in which the bottom chords and lower ends of diagonals had rusted out and have concluded beyond a doubt that the eating away of the members is caused by the use of the bridge by dogs as a water-closet. From the diagram with the article referred to, it can be noted that the drip of urine striking member U_1L_2 would fall on the bottom chord directly under and might cause the break there.

We recently repaired a foot bridge for the Botany Worsted Mills at Passaic, N. J., where the evidence against the dogs was unmistakable.

The remedy would seem to be to put up a plank guard that would present a smooth surface about 18 in. high on each side of the truss. E. G. TROWBRIDGE,

Engineer, Passaic Structural Steel Co.

Paterson, N. J., Apr. 6, 1916.

Laws of Sound in Auditoriums

Sir—The acoustic properties of a building are popularly supposed to be the result of mere chance. This supposition, founded on ignorance, doubtless accounts for many beautiful public buildings put up at large expense turning out to be acoustic disappointments and worse.

The voice of a speaker in the auditorium of the Chamber of Commerce in one of our Middle West cities sounded like a voice in a sepulcher because of sound vibration, until the walls of the auditorium were covered with a sound-wave absorbing material. A great church fared but little better. Quite recently a chapel, an architectural jewel set ideally in the edge of a city park, turned out so bad acoustically that but 70% of the words of the speaker could be heard. It is impossible to listen with enjoyment to an address in a convention hall in a city on the Pacific Coast, because of sound vibrations, due probably to defective interior design.

An amusing incident caused by poor acoustics occurred during a xylophone solo in a concert held in the convocation hall of the University of Illinois. The orchestra leader heard the echo louder than the instrument itself and beat time to the echo. The echoes have since been reduced by wall hangings.

Notable among buildings having excellent acoustics is the Hill auditorium at the University of Michigan, seating some 5,000 persons. The new Boston opera house, built after consultation with experts, is an equally fine example of the application of the laws of sound to architecture. The Mormon Tabernacle at Salt Lake City, holding 8,000 comfortably, has long been famed as the place where a pin may be heard drop at a distance of 200 ft. The acoustics of this auditorium was a piece of good fortune.

Next to architects, engineers ought to know and tell the public that the laws of sound as applied to auditoriums are now so well understood that the acoustic properties of any structure can be definitely determined before a single stone is laid. It is the contention of eminent physicists who have made a study of the subject for two decades that with very little additional expenditure the structure may be designed so that both speaker and music may be heard without effort. If builders could be brought to give heed to architectural acoustics, just as they give attention to strength, fireproofing and similar features considered necessary, there would be no need for suffering acoustic disappointments.

Lexington, Ky., Mar. 19, 1916. D. P. CLEVENS.

[From Prof. Dayton C. Miller, Department of Physics, Case School of Applied Science, Cleveland, Ohio, we learn that in his opinion the most important useful published information on the acoustics of auditoriums is by Prof. W. C. Sabine, of Harvard University, in "The American Architect," Vol. 68 (1900), pages 3, 19, 35 and 43 and Vol. 104 (1913), pages 257 to 279. The earlier articles deal with reverberation and the later one with echoes. Another useful reference is to a pamphlet of 32 pages, "Acoustics of Auditoriums," by Prof. F. R. Watson, in Bulletin 73 of the Engineering Experiment Station of the University of Illinois. This pamphlet contains an extensive bibliography of the subject.—Editor.]

NOTES AND QUERIES

The Needles Bridge Across the Colorado River, between Arizona and California, described in "Engineering News," Apr. 6, 1916, p. 672, was fabricated by the Kansas City Structural Steel Co., not the Kansas City Bridge Co., as stated in that article.

Cost of Cement Testing—In the article with the foregoing title, by Frank H. Carter, published in "Engineering News" of Mar. 9, 1916, p. 471, in the table of "Cost of Apparatus" the item "1 three-section gage mold, $9.60" should be corrected to read "2 three-section gage molds, $19.20," making the total of the table $219.52. "Cost per barrel" should also be changed from "4.20c. to read "4.39c."

A $2,000,000 Damage Suit brought by Memphis, Tenn., against the St. Francis Levee Board for overflow claimed to have been caused by the raising of levees near Memphis has been denied on demurrer by the United States District Court at Little Rock, Ark. The court held that the levees were intended to be permanent and that the Levee Board, the Memphis Bridge Co. and various railroads that were made parties to the suit were justified in raising the levees to a height sufficient to protect the property behind them.

East River Tunnels Show No Movement—Engineers of the Public Service Commission for the First District have just reported the result of an inspection of the south tube of the Battery-Joralemon St. subway tunnel under the East River. The inspection was made to ascertain the extent of change, if any, in the position of the tube since the time of its completion in 1908. Careful observations were made, and it was found that during the period of eight years in which this tube has been in daily operation there has been absolutely no settlement. Other observations showed that there had been no movement whatever in a lateral direction. Examination of the lining of the tube showed that the leakage, which has always been slight, has materially decreased during the period of operation.—The engineers will make a similar inspection of the north tube of the same tunnel within a short time.—Public Service Commission, New York, Weekly Bulletin.

Should Engineering Societies Pass on Public Questions?

By Hugh J. Duffield*

A short time ago a reinforced-concrete structure was being built in a certain city under the supervision of that city's engineer. Rerolled steel, employed as the reinforcing material, was objected to by one of the city aldermen, who brought the matter to the notice of the council. The city engineer was asked to explain. The argument fast degenerated to the see-saw order, and a deadlock resulted. The papers then took a lively interest in the matter, and last of all that Colossus of astute intelligence—the man-in-the-street—began to furbish up some of the minor parts of his subconscious stratum.

When a deadlock is established in a controversy, one of the contending parties is very apt to undertake hasty action. Otherwise, complete collapse results. In this particular case the council, instead of taking the matter in hand and obtaining a report on the dispute by some competent person, collapsed.

What next happened was to the writer incomprehensible. An engineering society, uninvited, informed the council that it would be pleased to go into the matter, its services to be given free. The old adage, "Beware of entering into a quarrel," etc., had no terrors for the society. It did not occur to the members that they were exposing themselves to a rebuff in case the council awakened to a sense of its responsibility and again took the matter into its own hands.

This incident brings up the question, Have our engineering societies the right to assume the rôle of adjudicator on all subjects of an engineering nature? The writer wishes, if possible, to ascertain on what authority some individuals have assumed to pass upon engineering matters and then branded their findings with the name of an engineering society. In looking through the constitutions of engineering societies it is difficult to find any laws or rules that clothe the members with judicial authority. Neither has the writer ever heard of any unwritten law or custom bearing on the subject. From this he concludes that the members of our societies never intended that their names should be used in public investigations such as that just cited.

No matter how high sounding our societies' titles may be, we should never lose sight of the fact that these associations are composed of fallible men. Our societies generally recognize this fact, and for this reason they have not included in their plan of organization any provision for investigations of a public nature. As an illustration of the statement that engineering societies are composed of fallible men, the writer asked one of the executives of the society that proposed the investigation referred to what his views were on the subject. This gentleman said that he did not care two straws whether any reinforcing was used in the structure or not! This statement is analogous to that of a baker who informs you that he can make currant bread without currants.

When a society intrudes in such a manner, we naturally ask ourselves, What is this being done for? It is said that there is never a good action done but that there is a small grain of bad in it. The truth of this saying can be seen on a moment's reflection. Did the society offer its services with the intention of placing its decision in the category of "no higher appeal," or was there some strenuous consideration?

If the intention was to place the finding of the society above the opinion of the individual, then the society is curtailing the freedom of the profession. If the intention was to allay the public's fear concerning the material under discussion and if the finding was given with respect to this, then the interference of the society was most harmful. Such a decision would have an influence not measured by the engineering ability of the investigators at all, but measured solely by the good or bad judgment of the men composing the committee. Nevertheless, the committee's decision, being announced as an action of the society, would have with the public a weight that it otherwise would not have. If engineering societies are going to interfere when and where they think proper, what will be the state of mind of the private practitioner? He will never know when he may be brought to account.

Engineering has long passed the stage of mere algebraic formulas. We are no longer dealing only with the x's and the y's; other elements, often very difficult to estimate, have entered into the calculation. They may take the form of expediency or they may be cost figures or they may come under some other head. These other elements have under present conditions a strong influence on our engineering calculations. They are often the controlling considerations. In other words, they are functions of our engineering problem and will often determine the success or failure of a scheme. Our engineering societies, judging from their constitutions, are not concerned with anything outside engineering science, so the harmonizing of this science with general advancement should be left with the private practitioner. For these reasons the writer believes that our societies should not take upon themselves the rôle of "courts of appeal."

*Consulting Engineer, 309 Beveridge Building, Calgary, Canada.

Portable Washer for Aggregate

The simple and portable washer shown in the accompanying illustration is intended especially for cleaning and grading material at small concreting plants or on small jobs where the washing must be done near the work.

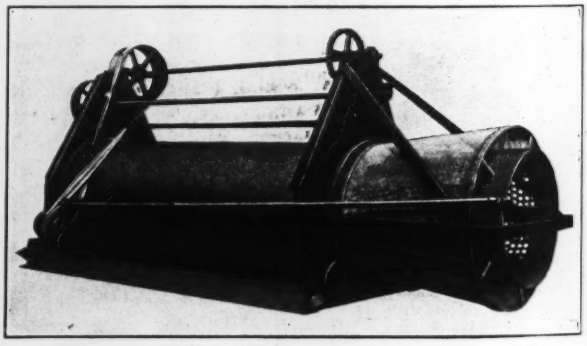


FIG. 1. PORTABLE WASHER FITTED WITH ROTARY SCREEN

The machine may be placed under a platform having a trap or hopper, so that the material can be delivered directly into it from scrapers or wagons. Fig. 2 gives the construction, and Fig. 1 shows one of the machines with a double-cylinder rotary screen attached.

The washer consists of a steel drum about 30 in. in diameter and 8 ft. long, having cast-iron heads, which rest on rollers. The drum is revolved by a sprocket chain that passes around one of the drum heads and over a pinion geared to a shaft which may be belted to a 2-hp. engine or motor. The drum runs at about 6 r.p.m. To

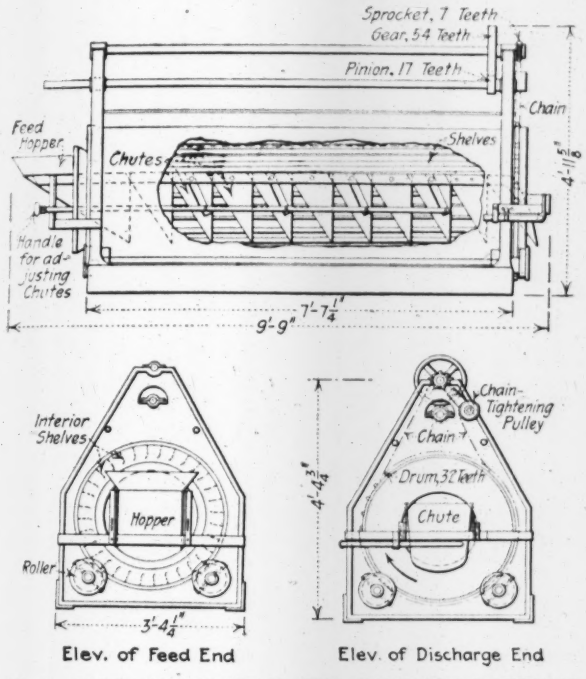


FIG. 2. PORTABLE WASHER FOR CONCRETE MATERIAL
Stocker Concrete Material Co.

the shell of the drum are riveted horizontal angles to which steel plates, or shelves, are attached. Within it also is a series of inclined chutes of spiral form. These are adjustable and can be shifted to any desired angle, according to whether the material contains much or little foreign matter and must be passed through slowly or rapidly.

The drum is partly filled with water, which enters at one end. The gravel is delivered to a feed hopper (at the opposite end from the water feed) and falls to the bottom of the drum. The horizontal ribs in the drum carry the gravel up until it drops into the first chute, by which it is delivered a little farther forward and dropped into the water, to be again carried up and dropped into the next chute. As the gravel moves forward, it meets cleaner water; and by the time it reaches the end of the drum the washing is completed. The washed product may be delivered to a screen attached to the drum, as in Fig. 1, or to a conveyor or storage hopper.

The washer is mounted on a frame 3½x10 ft. and weighs about 2,000 lb. complete. Its capacity is 50 to 60 yd. per 10-hr. day, with a water supply of 10 to 15 gal. per min. It can be fitted with a rotary pump, if desired. It is used on contract work and at gravel pits or stone quarries, also for cleaning the sand at water-filtering plants. Larger machines, handling 200 to 1,800 cu.yd. per day, are built for service at large concrete and gravel plants where the material is delivered to storage bins. These machines are built by the Stocker Concrete Material Washer Co., Highland, Ill.

Competition for Designs for Railway Camps

Adequate and sanitary housing accommodation for men engaged on railway construction and maintenance work is considered by the National Americanization Committee, of New York, as one important means of conserving the supply of unskilled labor and promoting a higher standard of living among the foreign-born workmen. With this in view it has instituted a competition of designs for substitutes for the old box-cars frequently used in housing construction gangs. The committee points out that men who have lived for several months in a construction camp where old and crowded box-cars are the only dwellings and where plumbing, drainage and sanitary conveniences are not provided are not likely to be in condition at the end of the season to face a hard winter in city factory work. Further, many of these men are immigrants, and ordinary camp conditions teach them low standards of living, which they follow when they return to the cities. The purpose of the committee is to conserve the strength and energy of the men and to promote among them an American standard of living.

The specifications covering the competition state that the proposed camp-car outfit should permit of flexibility with regard to the number of men to be accommodated both with eating and sleeping facilities. Consideration will be given to economy of space, arrangements for clothing and cubic air-space capacity. It is assumed that there will be provided a site with spur track for the cars, a well or other supply of water, and old passenger cars (50 ft. long exclusive of platforms) having all seats, lamps and other movable equipment removed. The competition, however, also allows designs of new cars constructed specially for camp service.

The bunk cars should be so equipped that suitable units will afford sleeping accommodations for gangs of different sizes. Ordinarily such gangs are in multiples of 20. One or more eating cars must be provided. The designs must cover heating, ventilation, means for frequent fumigation and for making the cars proof against vermin and flies. Adequate toilets must be shown, at least 150 ft. from the cars, with provision for making them flyproof and for the use of deodorants. Receptacles must be provided for kitchen waste. Drainage of the site must be provided and the system described.

The drawings required include a general plan of the camp and plans and sections of the cars. Three prices are offered: $300, $200 and $100. Designs will be received until June 1. They will be submitted to a jury composed as follows: R. S. Parsons, Chief Engineer, Erie R.R.; James B. Brady, Vice-President, Standard Steel Car Co.; George A. Cullen, Passenger Traffic Manager, Delaware, Lackawanna & Western R.R.; Francis A. Kellor (formerly Chief of New York State Bureau of Industries and Immigration); Dr. Andrew J. Provost, Lederle Laboratories. Information as to the details of the competition may be obtained from the National Americanization Committee, 18 W. 34th St., New York.

Electric Power Required for the recent Panama-Pacific Exposition had a maximum peak of 8,200 kw. This came shortly after the exposition opened on Feb. 20, 1915. During the exposition proper the total energy required was 15,986,085 kw.-hr.; including the pre- and post-exposition periods, the total amounts to 18,321,000 kw.-hr. The maximum daily draft was 80,000 kw.-hr., which cost $320,200.

News of the Engineering World

Federal Road Appropriations Unlikely This Year

Federal aid to highway construction was sidetracked in the Senate on Apr. 21, after the bill making appropriations for such construction had been under consideration by the Senate for three days. The House passed by a large majority several weeks ago the Shackelford bill appropriating $25,000,000 for Federal aid to state road construction. The Senate committee amended the Shackelford bill by striking it out entirely and framing a new measure appropriating $5,000,000 for the year ending June 30, 1917; $10,000,000 for the following year and thus increasing by annual increments of $5,000,000 to an appropriation of $25,000,000 in the year ending June 30, 1921.

This money was to be expended on improvements of rural post roads, defined as "any public road over which the United States mails are or might be transported," with the exception of streets and roads in towns of 2,500 or more population where the houses average closer together than 200 ft. The construction of these roads was to be in charge of the State Highway Departments of the several states, and the Federal Government was to contribute not more than 50% of the cost of improving the roads, approve plans and specifications for the improvement and inspect the work to see that it was done in accordance with the plans. A large number of senators from the West and South favored the bill, but the opposition was successful in preventing a vote on it.

Local Sections of National Engineering Societies

Whether by chance or intent, proof positive of coöperation among engineering societies was afforded within a week of the Conference on Engineering Coöperation, held in Chicago Apr. 13 and 14. Reference is made to a discussion of the relations between national engineering societies and their local sections, which was held at the rooms of the American Society of Civil Engineers on Apr. 19 and was participated in by representatives of that society and of the electrical, mechanical and mining national organizations.

The discussion was opened by Charles Warren Hunt, secretary of the American Society of Civil Engineers. Mr. Hunt stated that the first definite proposition for local sections was taken up by the American Society of Civil Engineers in March, 1905, when measures were instituted by the Board of Direction to get the opinions of three or more members located in each of a number of different cities as to the advisability of section organization. Sections were organized in Kansas City, San Francisco and Memphis in 1905, but little or nothing has been heard from the Kansas City or Memphis sections. The San Francisco section has been very useful. In 1908 the Colorado Association (as these American Society sections are called) was organized with headquarters at Denver. At present there are 15 local associations of members.

In January, 1915, a proposition for district organization arose. A recent ballot of the society participated in by some 3,100 members showed a majority in favor of district organizations.

Following the remarks by Secretary Hunt, a letter from President Corthell was read. He suggested a central or national conference committee and various local conference committees of representatives of engineering societies. He also favored bringing engineers not members of any of the societies into conference.

Speaking for the American Institute of Electrical Engineers, Paul M. Lincoln, past-president, stated that its movement for the establishment of sections was begun in 1892. The first section was formed in Chicago in 1893. There are now 32 sections, besides 53 student branches. Stress has been laid upon coöperation between the local sections of the institute and other engineering bodies in the same city.

The American Society of Mechanical Engineers, said President D. M. Jacobus, now has 15 local sections. He stated further that during his presidency he hoped to visit nearly all, if not all, the sections. He added that engineers must get over the idea of antagonism and must coöperate.

The American Institute of Mining Engineers, according to Past-President W. L. Saunders, adopted the section plan five years ago and now has 15 sections. Mr. Saunders has promised to go to Reno, Nev., to be present at the organization of a new section at that point in a few days.

Representatives of a half-dozen local associations of the American Society of Civil Engineers were called upon by Vice-President Clemens Herchel, chairman of the evening, for remarks. Prof. Charles T. Marx, Palo Alto, Calif., felt sure that the San Francisco Association had brought engineers into more public notice and had made better feeling among the engineers themselves.

John F. Coleman, New Orleans, outlined a scheme of coöperation among the engineering societies, both national and local, and also of coöperation between members and nonmembers of engineering societies.

Frank G. Jonah, St. Louis, said that no papers were read before the St. Louis Association of Members of the American Society of Civil Engineers. He said that association takes its turn with other local sections of national societies in presenting papers at the Engineers Club of St. Louis, with a membership of some 500.

Daniel Bontecou, Kansas City, Mo., said that the Kansas City Association of Members of the American Society of Civil Engineers was, as has already been stated, first in the field, but it was still-born. He had about reached the conclusion that local organizations should confine their efforts to local matter—an opinion which was expressed by some of the other speakers as well.

Prof. George F. Swain, Cambridge, Mass., remarked that they were all members of one profession and not of several and could accomplish the most by coöperation. He had often thought of what would be the best way of organizing the engineering profession if it were not already organized. His conclusion was that a single society of American engineers, with sections, would have been the best plan.

Herbert S. Crocker, Denver, said the Denver Association had been very successful in getting members acquainted with one another and with one another's work. Its greatest difficulty is that of expense. The $2 annual dues are too small to enable the association to accomplish much, and the parent society does not rebate from annual dues to it in order to help support the local section.

At the suggestion of Secretary Hunt, John Bogart, who was secretary of the American Society of Civil Engineers before any of the other national engineering societies except the Mining Engineers was formed, was called upon. Mr. Bogart said he favored local sections. He agreed with Professor Swain as to one great engineering society being the ideal and wished that there had been one great all-embracing national engineering society.

Excluding Trash, Roots and Grease from Sewers

How to lessen sewer stoppages was one of the leading subjects discussed at the first district meeting of the newly organized New Jersey Sewage-Works Association, held at Plainfield, N. J., on Apr. 18.

Stoppages have been noticeably reduced at Atlantic City, said Frederick T. Parker, who is carrying on an educational campaign. The means adopted to this end was the insertion of printed matter with all bills sent out. Somewhat similar experience is reported from another city, where circulars have been distributed, bringing home to householders the fact that upon them finally comes the extra expense of sewer maintenance due to their carelessness in admitting material that would stop sewers. In still another city troublesome stoppage has been reduced by sending bills for the labor involved in removing stoppages, accompanied by photographs of the trash removed.

At Riverside a trap similar to a grease trap, but with a netting over its outlet, has been used to catch stockings and towels that have been started on their way to the street sewer.

Coming now to the subject of grease in sewers, Mr. Parker stated that Atlantic City passed an ordinance requiring the installation of grease traps on every house connection, but that it has not been possible to enforce the ordinance. (It should be mentioned that the sewerage system of Atlantic City is owned and operated by the Atlantic City Sewerage Co.) Mr. Parker stated that records from an average cottage in Atlantic City, housing six or seven people, show a collection of 1½ bbl. of grease per year. If all houses and hotels had grease traps, the 10,000 bbl. of grease could be collected per year. The company has considered making an attempt to enforce the ordinance and letting a contract for the collection of the grease.

The question as to the possibility of removing roots from sewer pipes by means of chemicals led to considerable discussion. It was the consensus of opinion that, whatever means might be taken to remove roots, the pipe would be continually clogged by new growths unless the pipes were taken up and relaid with bituminous joints. Both poplar and willow trees were scored. One member reported that an educational campaign had resulted in voluntary cutting down of all poplar trees by the citizens, but another stated that the mere mention of cutting down such trees in his town had been met with so much protest, including the threat of court action, that the project had been abandoned. I. Z. Collings, Collingswood, N. J., said that the life of a house connection in a yard containing a weeping willow tree was only one year.

Amending Constitution of Civil Engineers

To guide them in their task of submitting a report on the revision of the constitution of the American Society of Civil Engineers, the committee having the matter in charge asked the directors to take a letter ballot on six points. The vote was announced informally at the meeting of the society on Apr. 19. Two propositions were carried by about an 86% vote out of the 3,200 ballots cast. These measures were the recent suggestion for organizing the society by districts and the proposal that the Board of Direction be given authority to discipline and to expel members.

There was a close vote on the admission of women to membership in the society, with the negative slightly in excess. On the question of admitting salesmen there was a decided negative majority. Whether professorial duties in an engineering school of recognized standing should be held to be equivalent to responsible charge of engineering work hereafter was decided in the negative by a 58% vote. The proposition to raise the admission requirements for membership of the highest grade was defeated by an actual majority of 24 votes.

The New York Central West-Side Lines' grade-crossing elimination in New York City, as noted in "Engineering News," Jan. 20, 1916, p. 140, has progressed to the stage where detailed plans have been filed with the Board of Estimate by Port Terminal Committee. Public hearings on the proposal will be held before final action is taken by the city. Two original sets of plans have been prepared—one for exhibition at the Grand Central Terminal offices and the other in the City Hall.

To Introduce American Goods Into Russia the American-Russian Chamber of Commerce, 60 Broadway, New York City, has decided to prepare a handbook on American financial and commercial conditions for exclusive distribution in Russia. This book will be in the Russian language and will contain a section devoted to a concise and summarized survey of industrial and commercial conditions in this country and a directory of selected American business houses prepared to furnish goods to the Russian market.

Water-Works Improvements at Lawrence, Kan., proposed for immediate execution include an iron-removal and softening plant, pumping equipment, flood protection and extensions, of the distributing system. A bond issue of $200,000 for these improvements has just been given popular approval. The city commissioners have invited engineers to submit propositions until Apr. 24 for doing the necessary engineering work. A month or so ago the city voted to buy the works of a private company. E. H. Dunmire is city engineer.

A Bill To Establish Engineering Experiment Stations has been introduced in Congress by Senator Newlands, this being the bill described by A. A. Potter "as proposed" in "Engineering News," Nov. 18, 1915, p. 995. In each state there would be

established an experiment station to study the detailed application of engineering and mechanic arts to the industries of the state—including work in water purification, sewage and wastes disposal, flood protection, road building, etc. Each state would get $15,000; the stations would be under the supervision of the Secretary of the Interior.

A $7,000,000 Trunk Highway System for New Jersey was authorized by the recent session of the Legislature, subject, however, to approval by referendum vote in November, 1916. Thirteen trunk routes, with a total mileage of about 350, are comtemplated. The $7,000,000 of bonds bears 4% interest and would be payable $500,000 yearly. This payment, with interest charges, would be met from the state motor-vehicle license fund. The routes are laid out in general terms in the bill. The exact details of the location, together with construction work, will be in charge of a highway commission of six. Four of the members would be the Governor, the President of the Senate, Speaker of the House and the State Road Commissioner acting ex officio. The other two members would be the Chairman of the Senate and House Highway Committees of the Legislature of 1916.

A Civilian Engineers Training Battalion, so called, has been formed by some 400 of the men in New York City who have been attending the lectures given under the auspices of a joint committee of the four national societies having headquarters in New York. These men have been taking military instructions at the Seventy-first Regiment armory on Thursday afternoons from 5:30 to 7 p.m. and at the Twenty-second Regiment armory on Tuesday evenings at 8.15. The object is to give such military training as may be available to engineers without interference with their regular business duties. The work will include military drill, in close and extended order; fieldwork, both tactical and engineering; rifle practice; and week-end encampments. All engineers are welcome at these drills, and they may enroll by applying at either armory. This battalion will continue to act under the auspices of the Committee on Military Engineering Lectures. The formal organization consists of an executive committee of which R. S. Buck, Engineer of Maintenance-of-Way of the New York Railways Co., is chairman; the secretary is C. R. Hulsart, Assistant Engineer of the New York City Board of Water-Supply.

PERSONALS

Mr. Harry U. Mowery has been appointed City Engineer of Wooster, Ohio.

Mr. John A. Illiman, Boone, Iowa, has been appointed County Engineer of Boone County, in charge of roads and bridges.

Mr. James L. White, formerly employed as engineer at the Ames Iron Works, has been appointed Smoke Inspector in Minneapolis, Minn.

Mr. W. W. Morehouse, Marshalltown, Iowa, has been appointed County Engineer of Polk County, with headquarters at Des Moines, Iowa.

Mr. Albert Wolstenholme, M. Am. Soc. C. E., formerly Superintendent of Streets of Fall River, Mass., has been appointed City Engineer of that city.

Mr. Edwin D. Hayward, a member of the faculty of De Pauw University, has been appointed Instructor in Civil Engineering at the University of California.

Mr. Rankin Duvall has been engaged as Road Engineer for the reconstruction of highways in Scott County, Kentucky. He is a graduate of the University of Kentucky.

Mr. Robert McCormick, who has been in the City Engineering Department of Boone, Iowa, for the past three years, has been appointed City Engineer to succeed Mr. Karl C. Kastberg.

Mr. Frank B. Manning has been appointed Superintendent of Streets of Fall River, Mass., to fill the vacancy created by the promotion of Albert Wolstenholme to the position of City Engineer.

Mr. H. O. Hickok, Rochester, N. Y., has been appointed County Engineer of Marshall County, Iowa, with headquarters at Marshalltown, Iowa. He is a graduate of the University of Michigan.

Mr. W. F. Langelier, at present connected with the Illinois State Water Survey, University of Illinois, has been appointed Assistant Professor of Sanitary Engineering of the University of California.

Mr. John C. Craig, Assistant Superintendent of the Roll Department of the Steelton, Penn., plant of the Pennsylvania Steel Co., has been made Superintendent of the Rod and Structural Mills.

Mr. J. M. Estep, M. Am. Soc. C. E., formerly Assistant Chief Engineer of the City of Cleveland, Ohio, will open an office in the Marshall Building in that city about May 1, for the practice of engineering.

Mr. James H. Roach, Assoc. M. Am. Soc. C. E., formerly Assistant Valuation Engineer of the New York Central R.R. lines west of Buffalo, at Cleveland, Ohio, has been appointed Valuation Engineer.

Mr. F. L. Wheaton, Engineer of Construction of the Delaware, Lackawanna & Western R.R., at Nicholson, Penn., has been appointed Division Engineer at Binghamton, N. Y., to succeed the late C. E. Wickham.

Mr. W. A. McTighe, formerly Assistant City Engineer of Memphis, Tenn., has become a member of the engineering firm of Baum & Haynes, Texarkana, Ark.-Tex., which will hereafter be known as Baum, Haynes & McTighe.

Mr. Floyd Angel, Assoc. M. Am. Soc. C. E., Hailey, Idaho, has been engaged as a supervising engineer on a large contract for county-road work in the vicinity of Sandusky, Ohio, in which city he will be located for at least a year.

Mr. Frank O. Dufour, Assoc. M. Am. Soc. C. E., has resigned as Senior Structural Engineer of the Central District, Division of Valuation, Interstate Commerce Commission, to go with the Stone & Webster Corporation at Boston.

Mr. F. E. Barnes, recently Chief Engineer and Manager of the Contracting Department of the R. T. Ford Co., Rochester, N. Y., has accepted a position with the New York Central R.R. Valuation Department, in charge of valuation of buildings.

Mr. John R. Wilbanks, Assoc. M. Am. Soc. C. E., has been appointed Chief Engineer of the Ferrocarril Samana y Santiago, with headquarters at Sanchez, Santo Domingo. He succeeds F L. Weakland, M. Am. Soc. C. E., who recently resigned.

Mr. Karl Kastberg has been appointed City Engineer of Des Moines, Iowa. He was formerly City Engineer and Superintendent of Municipal Water-Works at Boone, Iowa, for 13 years and previous to that time was Assistant City Engineer of Des Moines.

Mr. John W. Budd has been elected Superintendent of the Department of Streets and Public Improvements of Des Moines, Iowa. He has been Assistant City Engineer and was Assistant Engineer on construction of one of the reinforced-concrete bridges over the Des Moines River.

Mr. Edgar B. Thomas, M. Am. Soc. C. E., formerly Assistant Engineer in charge of the River and Harbor Department of the City of Cleveland, Ohio, has opened an office at 1159 Leader-News Building as a special Consulting Engineer in river, harbor, port and municipal-improvement work.

Mr. Thomas D. Pitts, M. Am. Soc. C. E., formerly First Assistant Engineer of the Baltimore (Md.) Sewerage Commission, has been appointed Engineer in Charge of the Sewer Department under the reorganization of the various city departments by Calvin W. Hendrick, Chief Engineer of the City of Baltimore.

Mr. Amos Schaeffer, M. Am. Soc. C. E., Consulting Engineer in Charge of Sewers of the Borough of Manhattan, New York City, has been promoted to the position of Consulting Engineer of the borough. He succeeds Ernest P. Goodrich, who recently resigned. Mr. Schaeffer will receive an annual salary of $7,200.

Mr. Charles Saville, Assoc. M. Am. Soc. C. E., who was appointed Director of Sanitation of the Department of Health of Dallas, Tex., a year ago, has been made Director of Public Health of Dallas. He will have complete jurisdiction over all city matters affecting public health, including the city hospitals. Mr. Saville is a graduate of the Massachusetts Institute of Technology in sanitary engineering. He was formerly with Hering & Gregory, Consulting Engineers, New York City, and previous to his appointment as Director of Sanitation was connected with the firm of Bartlett & Ranney, Inc., Consulting Engineers, San Antonio and Dallas.

Mr. William Grant, M. Am. Soc. C. E., of the firm of Grant & Fulton, Consulting Engineers, Lincoln, Neb., has been appointed Associate Professor of Civil Engineering, in charge of water-supply and sanitary engineering, in the University of Nebraska, from which he graduated in 1897. For ten years after graduation Mr. Grant was in the employ of the Chicago, Burlington & Quincy R.R. He was City Engineer of Lincoln for three years and has since been in private practice. From 1912 to 1914 Mr. Grant made a special study at the Massachusetts Institute of Technology of the subjects to which his new appointment relates. He will continue as a member of the firm of Grant & Fulton.

OBITUARY

David H. King, Jr., former President of the New York Dock Co. and noted as one of the first builders of skyscrapers, died at his home in New York City on Apr. 20, at 67 years of age. Mr. King was President of the Park Commission of New York City under Mayor Grant and did much toward developing the city park system. He had charge of the erection of the Mills Building, which was the first big structure in New York City. He also built in New York City, Madison Square Garden, the first Equitable Building, Washington Square Arch, laid the masonry base of the Statue of Liberty and placed the statue in position on its arrival from France.

Frederick William Doane Holbrook, M. Am. Soc. C. E., who was connected for nearly 25 years with the Department of Yards and Docks at the Puget Sound navy yard, Washington, and served as Acting Head of the department a large part of that time, died at Seattle, Wash., on Apr. 13. During the Civil War he was Assistant Engineer in the defense of Washington, with the United States Army Engineers. Later he took up railway work and was at various times resident engineer at the east end of the Hoosac tunnel, division engineer with the Boston & Maine R.R., the Lake Shore & Michigan Southern Ry. and the Northern Pacific Ry., becoming Division Superintendent of the Yellowstone Division of the last-mentioned railroad in 1886. He became Manager of the Seattle, Lake Shore & Eastern R.R. in 1889, a year later was appointed Secretary of the Seattle Board of Public Works and in 1892 entered the Department of Yards and Docks. He was born at Boston, Mass., in 1840.

ENGINEERING SOCIETIES

COMING MEETINGS

AIR BRAKE ASSOCIATION.
May 2-5. Convention in Atlanta. Secy., E. M. Nellis, 53 State St., Boston.

CANADIAN RAILWAY CLUB.
May 9. Annual meeting in Montreal. Secy., James Powell, P. O. Box 7, St. Lambert, P. Q.

RAILWAY DEVELOPMENT ASSOCIATION.
May 9-11. Annual meeting in New Orleans. Secy., H. O. Hartzell, B. & O. R.R., Baltimore, Md.

NATIONAL FIRE PROTECTION ASSOCIATION.
May 9-11. Annual meeting in Chicago. Secy., Franklin H. Wentworth, 87 Milk St., Boston.

AMERICAN SUPPLY AND MACHINERY MANUFACTURERS' ASSOCIATION.
May 10-12. Convention in Pittsburgh. Secy., F. D. Mitchell, 1510 Woolworth Building, New York City.

TAYLOR SOCIETY.
May 11-13. Conference on scientific management in Cleveland. Secy., H. W. Shelton, Hanover, N. H.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.
May 15-18. Annual meeting at Hotel Sherman, Chicago. Secy., J. G. Crawford, 702 East 51st St., Chicago.

NATIONAL DISTRICT HEATING ASSOCIATION.
May 16-19. Eighth convention in New York City. Secy., D. L. Gasgill, Greenville, Ohio.

SOUTHWESTERN ELECTRICAL AND GAS ASSOCIATION.
May 17-20. Annual convention in Galveston, Tex. Secy., H. S. Cooper, Slaughter Building, Dallas, Tex.

NATIONAL ELECTRIC LIGHT ASSOCIATION.
May 22-26. Convention in Chicago. Secy., T. C. Martin, 29 W. 39th St., New York City.

MASTER BOILER MAKERS' ASSOCIATION.
May 23-26. Annual meeting in Cleveland. Secy., H. D. Vought, 95 Liberty St., New York City.

AMERICAN IRON AND STEEL INSTITUTE.
May 26-27. General meeting in New York City. Secy., J. T. McCleary, 61 Broadway, New York City.

NATIONAL CONFERENCE ON CITY PLANNING.
June 5-7. Conference in Cleveland. Secy., Flavel Shurtleff, 19 Congress St., Boston, Mass.

AMERICAN WATER-WORKS ASSOCIATION.
June 5-9. Convention in New York City. Secy., J. M. Diven, 47 State St., Troy, N. Y.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
June 14-17. Eighth semiannual meeting. Cleveland. Secy., I. C. Olsen, Cooper Union, New York City.

SOCIETY OF RAILWAY CLUB SECRETARIES.
June 16-17. Annual meeting in Atlantic City. Secy., H. D. Vought, 95 Liberty St., New York City.

TRI-STATE WATER AND LIGHT ASSOCIATION OF THE CAROLINAS AND GEORGIA.
June 21-23. Annual convention at Isle of Pines, S. C. Secy., W. F. Stieglitz, Columbia, S. C.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
June 27-30. Annual meeting in Pittsburgh. Secy., Charles Warren Hunt, 220 West 57th St., New York City.

AMERICAN SOCIETY FOR TESTING MATERIALS.
June 27-July 1. Annual meeting in Atlantic City. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia, Penn.

American Railway Association will hold its spring session at the Hotel Biltmore, New York City, on May 17. Reports will be presented by the following committees: Executive, Transportation, Maintenance, Automatic Train Stops, Relations between Railroads, Safe Transportation of Explosives and Other Dangerous Articles, Electrical Working, Legal and Traffic Relations, Prevention of Accidents at Grade Crossings, and Nominations. The election of a president and first vice-president will take place at this meeting. Officials connected with companies that are members of the association are invited to be present.

Taylor Society has announced the program of the conference on scientific management at Ann Arbor, Mich., May 11-13. The papers include: "Nature and Significance of Scientific Management," by H. P. Kendall, Plimpton Press, Norwood, Mass.; "Scientific Methods of Management Applied to Various Types of Industry," by S. E. Thompson, Boston; "Scientific Management in Operation of Public Service Corporation," by Charles Day, Day & Zimmerman, Philadelphia; "An Illustrated Trip through Scientifically Managed Factories," by H. K. Hathaway, Tabor Manufacturing Co., Philadelphia. There will also be round-table discussions on scientific management for industries employing continuous and noncontinuous processes, those making uniform and nonuniform products and for construction work, merchandising, etc.

National Conference on City Planning program has been announced for the meeting at Cleveland, June 5-7. The items of greater improtance include: "The Automobile and the City Plan," by Nelson P. Lewis, Chief Engineer, Board of Estimate, New York City, and J. H. Gillespie, Police Commissioner, Detroit; "Districting by Private Effort," by Alexander Taylor, Cleveland; "Districting by Municipal Regulation," by George McAneny, New York City; "The Money Value of Good Planning in Land Subdivision," by W. G. Harmon, New York City, and O. P. von Swenigen, Cleveland; "Cleveland's Needs and Achievements," by Lawson Purdy, New York City, and Werner Hegemann, Berlin; "Planning Problems in Cities of Less Than 100,000," by John Nolen, Cambridge; "How to Get Started in City Planning," by W. T. Johnson, San Diego; "Street Systems, Including Transit Problems," by Joseph Shirley, Baltimore; "High Buildings in the Business District," by A. C. Comey, Cambridge; "Overbuilding on Land Used for Dwellings," by Thomas Adams, Ottawa.

Engineers' Society of Western Pennsylvania has arranged for a series of five lectures on Military Engineering, which will be given each Wednesday evening during May at the Carnegie Music Hall, Pittsburgh. With the object of familiarizing men of engineering training and experience with the work of the military engineer and of showing the possibilites of service in time of need, four of the talks will be on strictly military topics and one on the important allied subject of industrial mobilization. Lieut. Col. Francis R. Shunk, Corps of Engineers, U. S. A., will take the subject "The Organization and Duties of Engineer Troops"; Maj. P. S. Bond, "Military Reconnoissance, Sketching and Surveying—Military Demolitions"; Capt. C. L. Sturdevant, "Field Fortifications and Methods of Trench Warfare—Siege Operations"; Maj. J. C. Oakes, "Military Roads, Bridges, Fords and Ferries." The last lecture will be by A. L. Humphrey, vice-president of the Westinghouse Airbrake Co., on "Mobilization of Material and Industrial Resources."

New Jersey Sewage-Works Association—At the first district or local meeting of this association, held at Plainfield, N. J., on Apr. 18, there was quite a discussion on the exclusion of trash, grease and roots from sewers, as reported separately elsewhere in this issue. A collection of gas from the sludge-digestion chamber and its utilization for lighting a pumping station were reported by I. Z. Collings, Collingswood, N. J. Similar evidence of gas production in considerable quantities led to the sounding of a note of warning as to the dangers of explosions in sludge-digestion tanks, a number of which have been reported.

Several members who reported that they had received communications regarding alleged infringement of the Cameron Septic Tank Co. were referred to the National Septic Process Protective League (F. G. Pierce, Secretary, Marshalltown, Iowa). A paper dealing with various phases of sewage oxidation and suggesting a new unit to denote sewage strength, which has been named "oxygen-capacity-demand," was read by John R. Downes, Plainfield, N. J., president of the association. Before leaving Plainfield the twenty-two members who were in attendance at the meeting were taken over the Plainfield sewage-disposal works and also over the sewage-disposal plant now under construction for Plainfield and for the boroughs of North Plainfield and Dunellen.

Appliances and Materials

Coal Crusher and Sampler

An automatic coal crusher and sampler making easy the accurate production of small samples of coal shipments or purchases is being built by the Sturtevant Mill Co., Park and Clayton St., Boston, Mass. The large sample, of course, has to be gathered from the shipment as before. The crusher has a capacity for reducing, to ¼-in. size or smaller, 3,000 lb. per hr., and it diverts any portion from 5 to 15% of the total passing through.

* * *

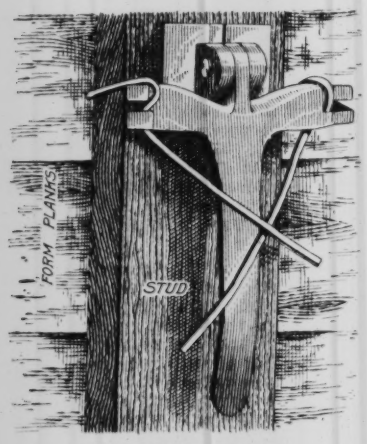
Sound-Absorbing Surface

A surfacing material that will absorb incident sound waves and that can be applied to walls and ceilings so as to become an integral part of the structure is being sold by the Tile Arch Construction Co., 7 East 42nd St., New York City, under the trade name "Amremoc." This material has been tested by Prof. F. R. Watson, of the Department of Physics, University of Illinois, and found to have an absorption coefficient of about 50%, which is 13% more than for hair felt (with which troublesome auditorium walls are padded). The material can be made to imitate any unpolished stone, both as to color and space covered. It is claimed to adhere strongly to rough tile or any similar surface; it can be applied after the walls are built and building closed.

* * *

Clamp for Form Tie Wires

The Universal wire clamp shown herewith is for tightening and holding wire ties in forms for concrete work. The tie is looped around the stud on one side and passed through holes in the form planking, the ends extending on either side of the opposite stud. The clamp is placed on this stud with the handle in vertical position above the tie, and the ends of the wire are slipped into the notched ends. The handle is then turned down, as shown, drawing the wire tight and holding it securely. For a thin wall, or where the wire is so straight as not to require tightening, the handle may be moved out 45° before placing the wires in the notches. This device is made by the Universal Form Clamp Co., 14 North May St., Chicago.



WIRE-TIE CLAMP

* * *

Reclosing Circuit-Breaker for Electric Networks

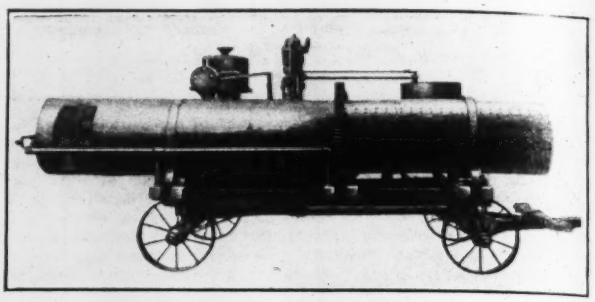
A circuit-breaker, of the automatic reclosing type but adapted for use on lines supplied from more than one source, has been developed by the Automatic Reclosing Circuit Breaker Co., of Columbus, Ohio, as an addition to its previous line. The ordinary form of automatic reclosing circuit-breaker is designed to control the entire current input to the load circuit and will not operate satisfactorily in a feeder circuit where such feeder is supplying current to a load circuit which is also supplied by current at other points.

The special feature of the new relay is a potential adjustment whereby the breaker may be set to reclose at any voltage from 50% normal to full voltage on the load side. Should the breaker open owing to an excessive load, it will reclose at the expiration of a short time interval, provided the voltage on the load side is not excessively low; should the voltage be excessively low so that the breaker would immediately open were it to reclose, the potential adjustment may be set so that the breaker will not reclose until voltage has risen to a safe value, but the instant the voltage does reach the allowable value, the breaker will automatically reclose. Should a short-circuit occur, the breaker will of course remain open until the short-circuit has been removed.

* * *

Portable Sand and Stone Drier

A light portable sand and stone drier was recently placed on the market by the Rapid Mixer Co., Grand Rapids, Mich. The arrangement of the outfit is shown in the view. The machine comprises a drum 12 ft. long and 24 in. in diameter, a 6-hp. gasoline engine, an oil tank, an oil burner and an air compressor for operating the latter. This equipment is mounted on a four-wheel truck. The drum is jacketed with asbestos at the burner end, and refuse can be kept out by a screen placed at the discharge end. The engine rotates the drum while the materials are shoveled into it and pass through under the action of gravity alone.



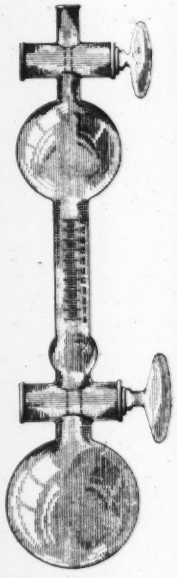
RAPID SAND AND STONE DRIER

The outfit was designed particularly for small asphalt plants, but may be used on any work requiring hot or dry aggregates. From 8 to 10 min. is required to produce material heated for use.

* * *

Pocket Flue-Gas Analyzer

A pocket CO_2 indicator for flue and furnace gases has been devised by the Bacharach Industrial Instrument Co., Pittsburgh. It is cheap, rugged, easily carried and operated. Two glass bulbs are connected by a graduated neck. Between one bulb and the neck is a three-way cock; between the other bulb and the air is a stop-cock. The device is used with the neck vertical and the open bulb at the top. After the lower bulb has been filled with KOH, the instrument is filled with gas (by a rubber tube and bulb) and the cock opened to the solution. After the CO_2 has been absorbed from the gas sample, the KOH is shut off, the instrument is immersed and the entrance cock opened, so that water flows in. The amount of water added and therefore the per cent. of gas absorbed are read directly on the neck.



POCKET FLUE-GAS TESTER

* * *

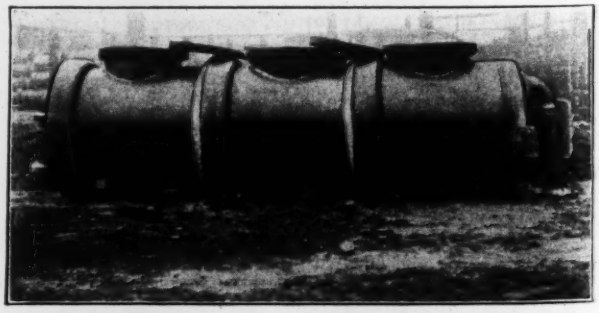
Colored Fireproof Shingles

Asbestos composition ("transite") shingles are being made by the Johns-Manville Co., of New York City, in a wide variety of colors, with rough edges and of double thickness.

* * *

Vitrified-Tile Septic Tanks

Special vitrified-clay tiles that serve as units for single-house sewage-disposal plants (like the typical one described in "Engineering News," Mar. 2, 1916) are a regular commercial product of the W. S. Dickey Clay Manufacturing Co., Kansas City, Mo., bearing the trade name "Adj-Cap." Each house tank has two or more sections, as shown in the accompanying view, according to the desired capacity. The tiles are 27½ in. in diameter and are separated by a perforated clay diaphragm. On each section is a 16-in. cleanout.



VITRIFIED TILE USED FOR SEWAGE DISPOSAL